ANNUAL REPORT

Provincial Board of Health

1916

Thirty-Fifth Annual Report

OF THE

Provincial Board of Health

OF

Ontario, Canada

FOR THE YEAR

1916

PRINTED BY ORDER OF

THE LEGISLATIVE ASSEMBLY OF ONTARIO

TORONTO:

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1917

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TORONTO

To His Honour Sir John Strathearn Hendrie, K.C.M.G., C.R.V.O., etc., etc., etc.,

Lieutenant-Governor of the Province of Ontario.

May it Please Your Honour.—I herewith beg to present for your consideration the Thirty-fifth Annual Report of the Provincial Board of Health for the year 1916.

Respectfully submitted,

Wm. David McPherson,

Provincial Secretary.

TO THE HONOURABLE W. D. MCPHERSON, K.C., M.P.P.,

Provincial Secretary of Ontario.

SIR,—I have the honour to submit for your approval the Thirty-fifth Annual Report of the Provincial Board of Health, made in conformity with and under the provisions of the Public Health Act, for the year 1916.

I have the honour to be, Sir,

Your obedient servant,

JOHN W. S. MCCULLOUGH,

Chief Officer of Health.

PROVINCIAL BOARD OF HEALTH OF ONTARIO

1916

The Board:

Adam H. Wright, M.D., M.R.C.S., Eng., Chairman ....Toronto.
Henry R. Casgrain, M.D. ....Windsor.
Thomas E. Kaiser, M.D. ....Oshawa.
William H. Howey, M.D. ....Sudbury.
A. A. Weagant, M.D. ....Ottawa.
James Roberts, M.D., M.O.H. ....Hamilton.

Executive Officers:

John W. S. McCullough, M.D., D.P.H. (Tor.), Secretary and Chief Officer of Health.
R. W. Bell, M.D., Provincial Medical Inspector.
Geo. E. Young, Alex. R. White, Sanitary Inspectors.

Laboratory Service:

John A. Amyot, M.B., Provincial Bacteriologist, Professor of Hygiene, University of Toronto.
H. M. Lancaster, B.A.Sc., Provincial Chemist, Professor of Chemistry, Dental College, University of Toronto.
R. W. Naylor, M.B., Assistant Bacteriologist.
A. R. Bonham, B.A.Sc., Assistant Chemist.
W. T. Connell, M.D., Branch Laboratory, Kingston.
W. H. Hill, M.D., D.P.H. (Tor.), Branch Laboratory, London.

Engineering Service:

F. A. Dallyn, C.E. (Tor.), Provincial Sanitary Engineer.
A. V. DeLaporte, B.A.Sc., Chemist in Charge of Experimental Station.

Child Welfare Bureau:

Miss Mary Power, B.A.

District Officers of Health:

District.
No. 1.—David B. Bentley, M.D., Sarnia.
No. 2.—Thomas J. McNally, M.D., Guelph.
No. 3.—Daniel A. McClenahan, M.D., Hamilton.
No. 4.—George Clinton, M.D., Belleville.
No. 5.—Paul J. Moloney, M.D., Cornwall.
No. 6.—W. Egerton George, M.D., North Bay.
No. 7.—Robert E. Wodehouse, M.D., Fort William.

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ANNUAL REPORT

OF THE

Provincial Board of Health for the Province of Ontario

For the Year Ending 31st December, 1916

RÉSUMÉ OF TRANSACTIONS OF THE BOARD BY THE CHIEF OFFICER

This is the Thirty-fifth Annual Report of the Provincial Board of Health for the year ending on the 31st day of December, 1916.

With the exception of Dr. H. R. Casgrain and Dr. James Roberts, all the members of the Board attended the regular meetings. Dr. (Lieut.-Colonel) Casgrain was invalided from Lemnos during the year and Dr. (Capt.) Roberts returned from the same place on sick leave during the spring. He attended the later meetings of the Board.

No new regulations were promulgated during the year.

Free Distribution of Biological Products.

Perhaps the most distinct advance made in public health during the year was the announcement made early in the year, of the Government's intention to furnish to the public, free of charge, diphtheria antitoxin, tetanus antitoxin, smallpox vaccine, anti-meningitis serum and Pasteur preventive treatment for rabies, in addition to typhoid vaccine which for some years had been supplied gratuitously. It will be remembered that these products had since 1914 been supplied to the public at prices much below those quoted by commercial firms. This arrangement had given universal satisfaction. It was felt, however, that a further advance should be made. The plan decided upon was that the Board should continue its arrangement with the Antitoxin Laboratory of the University of Toronto, namely, to purchase these products and supply them gratuitously to the public. The financial agreement is very satisfactory. The Board receives a requisition from Medical Officers of Health, hospitals or Boards of Health for these products, the requisitions are entered in books kept for the purpose and forwarded promptly to the Antitoxin Laboratory, which at once sends them to the parties making requisition. The bills are met by the Board monthly. The service is prompt and there is ample evidence of the satisfaction given to the public.

Antityphoid and Antiparatyphoid Vaccine.

Since about the first of June paratyphoid A and B have been added to the antityphoid vaccine prepared by the Board. Large supplies have continued to be supplied to the Department of Militia and Defence. The low incidence of typhoid and paratyphoid among Canadian troops both here and at the front is the best argument in favour of this protective measure. There is a gradually increasing demand for the vaccine from practitioners of medicine throughout the Province.

The activities of the Provincial Board of Health are already bearing fruit as evidenced by the distinct lowering of the death rate from diphtheria. This is due to the fact it is now possible in Ontario, to obtain antitoxin readily and at no ex-

pense. Many lives have already been saved, but even more will be accomplished when the war is over and an intensive campaign can be undertaken to save the lives of children who die of diphtheria because antitoxin is not used early enough and in sufficient quantity.

It may not be amiss to refer to the fact that the success of the scheme is due in a large measure to the princely gift made to the University of Toronto by Colonel Albert E. Gooderham. This consisted of the donation by that gentleman of a farm of some fifty acres and the necessary buildings and equipment for the purpose of a biological laboratory. These premises, to be known as the Connaught Laboratories, are situated about twelve miles north of the city, adjacent to Dufferin Street. The property has a delightful situation on the banks of the west branch of the Don River. The buildings are large, modern and of the most substantial character as the included cuts show.

The Board desires to express its profound appreciation of the interest in this important project manifested by the Director of the Antitoxin Laboratory, Dr. J. G. Fitzgerald, and the great assistance it has had at his hands in bringing the scheme to a successful issue. It cannot prove otherwise than of great value to the people of Ontario in the prevention of disease and in the promotion of the public health.

The Director of the Laboratory, Dr. John A. Amyot, has been serving as Major (more recently as Lieut.-Colonel) with the C.A.M.C. in France since the spring of 1915. His services here have been much missed, but reports from the front indicate that they are of greater value in the promotion of sanitary measures among Canadian soldiers. In his absence the direction of the laboratory has devolved upon H. M. Lancaster, B.A.Sc., Provincial Chemist, and the assistant bacteriologist, Dr. F. C. Schofield. Unfortunately in the latter part of the year Dr. Schofield decided to accept the post of bacteriologist with the Severance Union Medical College, of Seoul, Korea.

Dr. Schofield, during his association with the Board, had given evidence of exceptional ability. His energy and devotion to duty were remarkable. It was with the deepest regret that the members of the Board received his resignation. If, as it is sincerely hoped, his health is maintained in the foreign country where he has taken up his abode, there can scarcely be imagined the scientific attainments his genius may reach. Dr. Schofield's place has been filled by Dr. Naylor, a graduate of the University of Toronto.

Legislation.

The following amendments to the Public Health Act were passed during the 1916 Session of the Legislative Assembly:

Rev. Stat. c. 218, s. 8, amended.

Section 8 of *The Public Health Act* is amended by inserting therein the following clauses:—

Regulations as to plumbing.

(*dd*) The construction, repair, renewal, alteration and inspection of plumbing, the material to be used in the construction of, and the location of drains, pipes, traps, and other works and appliances forming part of or connected with the plumbing in any building or upon any property or in any highway, street, lane or public place, and in any structure or place, whether permanent or temporary, constructed or used thereon or therein.

The Connaught Laboratories, University of Toronto.

View of Laboratories.

An interior view of the Laboratory.

An operating room.

(*ddd*) The location, construction, repair, renewal, alteration, and inspection of sewers, drain pipes, manholes, gulley traps, flush tanks and other works in or upon public, municipal or private property forming part of or connected with any municipal sewerage system. Sewerage system.

Section 13 of *The Public Health Act* is amended by adding thereto the following subsection:— Rev. Stat. c. 218, s. 13, amended.

(10) The Provincial Board, every district officer of health and inspector, and every medical officer of health and sanitary inspector shall have authority to enforce the By-law set out in Schedule B, or any amendment thereof approved by the Provincial Board, and any by-law respecting the milk supply of, and any other by-law respecting sanitary matters in a municipality, and for this purpose may institute proceedings for the prosecution of offenders against any of the said by-laws. Enforcement of sanitary by-laws.

Section 37 of *The Public Health Act* is amended by adding thereto the following subsection:— Rev. Stat. c. 218, s. 37, amended.

(2) A medical officer of health who refuses or neglects to carry out the provisions of this Act or the Regulations, or any special order of the Provincial Board, or any by-law of the municipality relating to sanitary matters, may be dismissed from office by the Provincial Board or by the municipal corporation on the recommendation of the Board. Dismissal of M.O.H. for neglect of duty.

Section 53 of *The Public Health Act* is amended by adding thereto the following subsection:— Rev. Stat. c. 218, s. 53, amended.

(3) Every such notice filed with the medical officer of health shall be transmitted forthwith by him to the secretary of the local board of health, and shall be included in the weekly report required to be sent to the Provincial Board under section 24.

Sections 75 and 76 of *The Public Health Act* are repealed and the following inserted in lieu thereof:— Rev. Stat. c. 218, sections 75 and 76, repealed.

75. The Medical Officer of Health of any municipality, or any inspector or other person in the employ of the Local Board acting under his instructions, or any member of a Local Board may enter, inspect and examine at any time of the day or night, as often as he thinks necessary, any premises within the municipality for the purpose of carrying out the provisions of this Act, and may take such action as he deems necessary for carrying out the said provisions, and any person in charge of such premises for the time being shall render such aid to the Medical Officer of Health or other person as may be necessary to make such inspection or examination. Inspection of municipality.

Duty of medical health officer.

76.—(1) Every Medical Officer of Health shall see that the municipality or location for which he is appointed is regularly inspected in order to prevent nuisances or to abate any existing nuisance.

Examination of premises and order for cleansing.

(2) If upon such examination he finds any premises in a filthy or unclean state, or that any matter or thing is there which, in his opinion, may endanger the public health, he may order the owner or occupant of the premises to cleanse the same, and to remove or destroy what is so found therein.

Rev. Stat. c. 218, s. 103, subs. 1, amended.

(1) Subsection 1 of section 103 of *The Public Health Act* is amended by striking out the word "four" in the third line and inserting in lieu thereof the word "two."

Rev. Stat. c. 218, s. 103, subs. 2, amended.

(2) Subsection 2 of section 103 of *The Public Health Act* is amended by striking out the word "four" in the second line and inserting in lieu thereof the word "two."

Rev. Stat. c. 218, s. 110, amended.

Section 110 of *The Public Health Act* is amended by adding the following subsection:—

Penalty for selling biological products supplied by Board.

(4) Every person who sells either publicly or privately any of the biological products supplied to the public free of charge by the Board shall incur a penalty of $100, and in default of payment thereof shall be liable to imprisonment for a period of three months.

Rev. Stat. c. 218, s. 115, amended.

Section 115 of *The Public Health Act* is amended by adding thereto the following subsection:—

Effect of by-law, sched. "B."

(3) The By-law set out in Schedule B and any amendment thereof approved by the Provincial Board shall have the same force and authority as a regulation made under this Act by the Provincial Board.

Rev. Stat. c. 218, s. 125, subs. 2, amended.

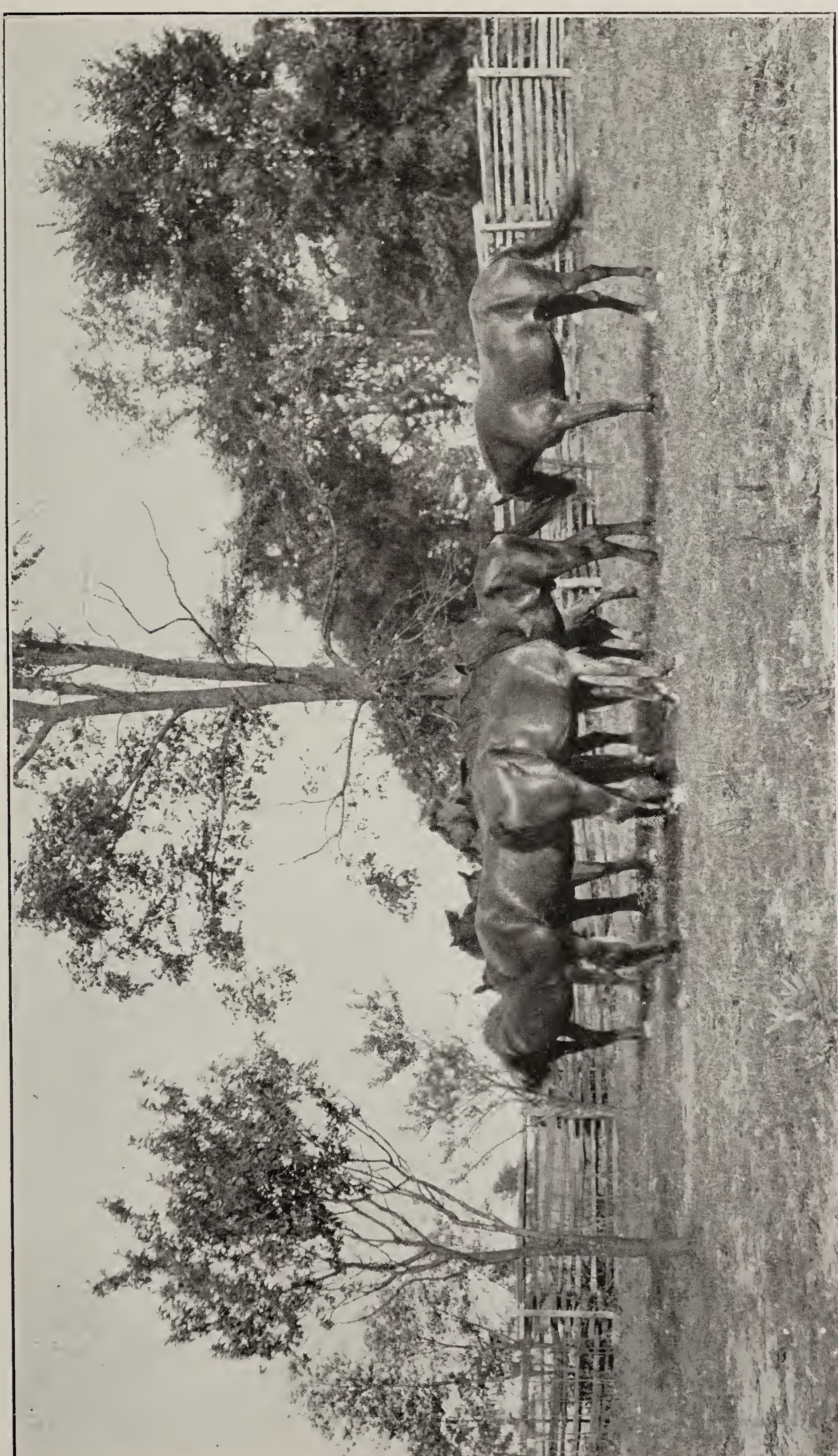
Subsection 2 of section 125 of *The Public Health Act* is amended by inserting after the word "officer" in the first line the words "or officers."

Water Supplies and Sewerage.

A full report in reference to the Board's supervision of waterworks and sewerage construction is given elsewhere in this volume by the Provincial Sanitary Engineer. It is evident that the public is appreciating more and more the advantages of pure water supplies, and the necessity of a more careful attention to a proper disposal of sewage. Many necessary works have been, to our regret, held up because of the stringency in the labour market, and the increased cost of material, due to the war.

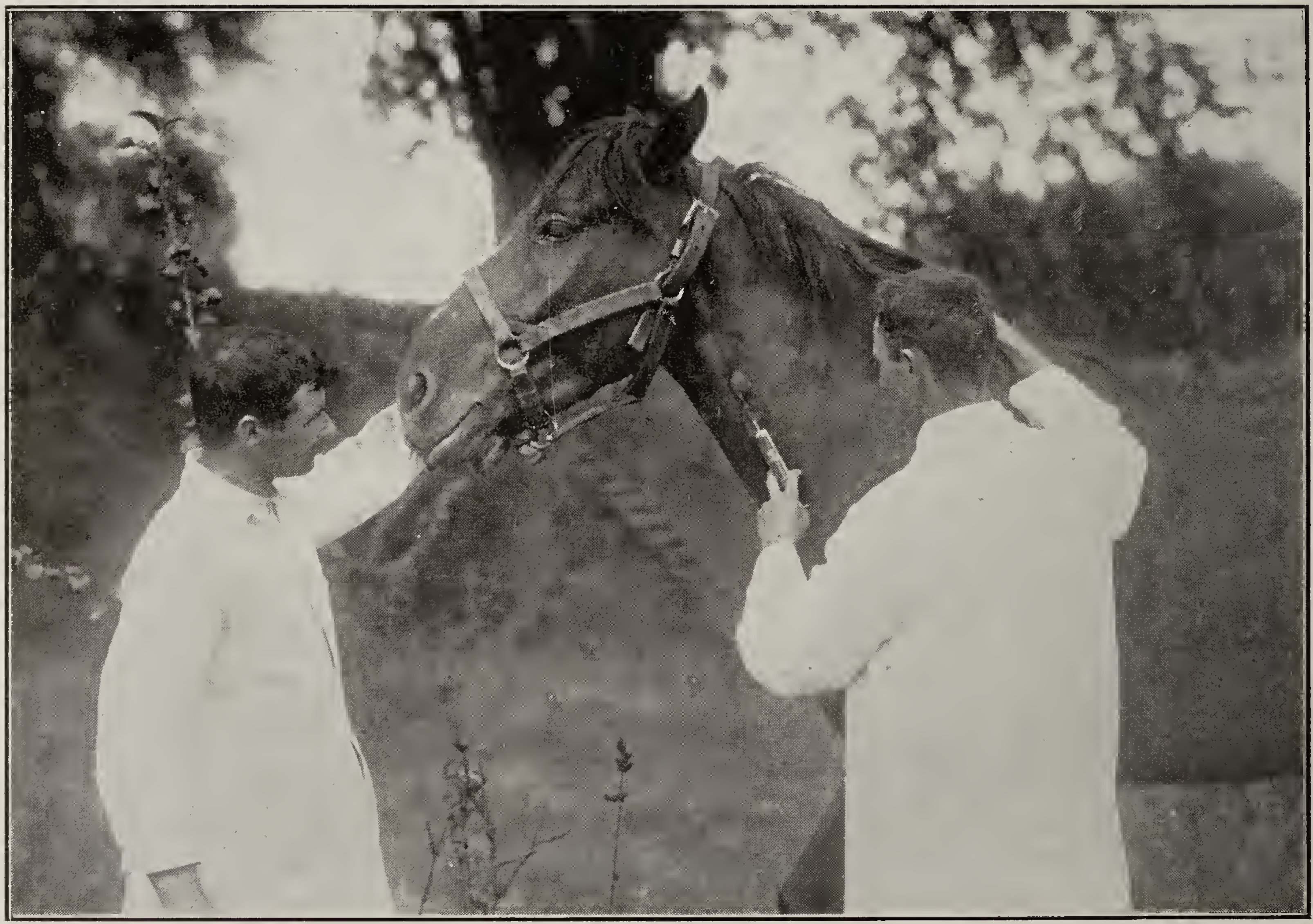
The Laboratories.

Medical men and the public generally continue to make increasing use of the extensive facilities of the Laboratories of the Board at Kingston, London and



A group of horses, Connaught Laboratories.

A group of horses, Connaught Laboratory.



Injecting Tetanus Toxin into one of the horses.

Toronto. The reports of the officers in charge of these laboratories are included herein. It is apparent that the service afforded is considered of very great value. The enactment of prohibition in September of this year has added greatly to the work of the Toronto laboratory because of the enormous increase of samples of liquor seized by the License Department, all of which are examined at this Laboratory.

The Experimental Plant.

This plant continues to carry on research work in relation to sewage and water. A full report is appended.

Annual Conference of Medical Officers of Health.

This Association continues to attract large and increasing numbers of the Medical Officers of Health in the Province. It is noticeable that the most up-to-date Medical Officers are those most constant in their attendance. In the absence of the President, Dr. A. W. McPherson, of Peterborough, who is on active service, the chair, at the recent meeting held in Toronto, was taken by Dr. Alex. J. Macaulay, M.O.H. of Brockville, who was elected to the presidency for 1917. Dr. T. A. Vardon, the veteran M.O.H. of Galt, always a notable figure at these and other medical meetings, was elected Vice-President. Unfortunately Dr. Vardon has since passed to the beyond. His ready tongue and genial presence will be missed at our future meetings.

Two interesting features of this meeting were the addresses given by Mr. T. Chalkley Hatton, C.E., Engineer to the Milwaukee Sewerage Commission on "The Treatment of Sewage by Activated Sludge," and by Dr. Wm. H. Park, of the New York Department of Health on "Diphtheria."

The list of papers was extensive and much above the average in value.

The District Officers of Health.

Additional work has fallen to the lot of the officers in districts two and six because of the absence, on active service overseas, of the officers of districts one and seven, whose work has in their absence been carried on by their confreres. In November the serious illness of Mr. Geo. E. Young, Sanitary Inspector in Northern Ontario, necessitated the appointment of Mr. Alex. R. White, whose good record as Sanitary Inspector of North Bay indicates that he will render valuable service to the Board.

Epidemiological Service.

The assistance given to municipalities by the district officers in the investigation and curbing of outbreaks of disease has been supplemented by the establishment of an expert epidemiological service, which will be at the disposal of Boards of Health and medical practitioners. In this way it is hoped to render effective aid, the more especially in relation to typhoid fever, infantile paralysis and cerebro-spinal fever.

Child Welfare Bureau.

The preventable deaths of infants is a subject demanding more attention on the part of Boards of Health than it has, in this Province at least, heretofore received.

The annual deaths in the Province of children under one year is now nearly seven thousand, which is equivalent to an infant mortality rate of 102—a rate capable of betterment in the light of present day knowledge.

The results of attention to this phase of public health in other countries such as Norway, Sweden, New Zealand and Australia indicate the value of life-saving measures in infancy. *No other variety of public health work is of greater value.* Prevention of the deaths of infants and young children *can* be accomplished.

In respect to this important subject, it is interesting to learn from the Milroy Lectures 1916 (S. G. Moore, M.D., D.P.H. Huddersfield), published in the London *Lancet* of April 22, 29, and May 6, 1916, that in the Village of Villiers-le-Duc, France, the infant mortality figure for ten years has been *zero*. I should like to include, because of their practical value, the entire series of lectures given by Dr. Moore, but as space will not permit the reader is referred to the journal mentioned for the information. In Villiers-le-Duc the astonishing fact of the entire absence of deaths among infants for the last ten years is accounted for by the enforcement by the Mayor of the following regulations:

Regulations.

The Mayor of Villiers-le-Duc, considering that the municipal authorities have the duty of endeavouring to stop the depopulation of the country by taking the measures necessary to prevent birth mortality and any child being stillborn, and to do away with infantile mortality, the municipal council orders as follows:—

Article I.—Every woman with child, whether married or not, having her home in the village, and not in possession of sufficient means to allow her to take upon herself the expense of the measures necessary to secure, as far as possible, not only her own life, but also that of the child about to be born, shall have the right to require the help of the village authority.

Article II.—In order to take advantage of this favour she must declare her condition at the office of the Mayor, before the seventh month, and she shall at the same time indicate by what midwife she wishes to be attended. The midwife named shall be requested by the official head of the village to visit the woman with child in order to ascertain for herself that there is present neither albuminuria nor dystocia either of the child or of the mother, nor dangerous presentation. For this visit there shall be allowed to the midwife a sum of (5 francs) 4s. 2d. out of the fund opened in the village for free medical aid, and without any share of liability on the State or on the department.

Article III.—In case the midwife, after this examination, shall consider that it is necessary to call in a medical man, she must at once notify the municipal authority without giving the reason for the notice. The authority shall then request a medical man, at the choice of the woman with child, to take the measures necessary to bring about the confinement successfully. The fees of the medical man shall be secured on the credit of the free medical aid fund without any liability on the State or department.

Article IV.—Every woman who is assisted by the Commune at her confinement shall receive a grant of 10d. per day during six days (not counting the day of her confinement) if she remains in bed. This grant shall be paid to her at the end of six days. If the woman gets up before the time fixed the grant shall be refused. The cost of this shall be defrayed from the free medical aid fund without liability on the State or the department.

Article V.—Every woman who takes in a child to nurse, if she does not feed it at the breast, or if she feeds it partly at the breast and partly otherwise, shall be bound to provide herself with an apparatus to sterilize the milk, and shall follow out, for the feeding of the child, the written instructions which will be supplied to her by the municipality. She shall on every occasion, when required by the municipality or by the visiting doctors, produce the sterilizing apparatus, the feeding bottles, full or empty, the teats, and other accessories, in such a way that it will be possible to ascertain that they are in good condition.

Article VI.—All the infants placed out to nurse shall be weighed every fortnight on the communal baby-weighing machine either at the office of the commune, if time permit, or at the home of the child. The increase of weight shall be noted on a slip kept separately for each child, and preserved at the office of the Commune.

Article VII.—Every nurse-child brought up at the breast or on the bottle who may be attacked by any illness, especially by diarrhœa, vomiting, or respiratory troubles, must be notified to the municipality with a maximum delay of not more than 24 hours from the first appearance of the illness.

Article VIII.—In case nurses who have charge of the infants do not conform to the regulations in Articles, 5, 6, and 7 above given, the certificate notifying their qualifications may be withdrawn from them eight days after the notification has been received without effect.

Article IX.—An apparatus for sterilizing milk and exchangeable parts of the apparatus shall be placed at the office of the authority for disposal to the nurses, who may purchase them at a reduced price. The mothers who nurse their own children, and who are known to be in a state of poverty, shall be able to obtain on loan, without charge, a sterilizing apparatus which they shall return to the office after the weaning of the child.

Article X.—Every nurse bringing up her own child, or a child entrusted to her, whether at the breast or by bottle, who shall produce the child in a good state of health at the age of one year, shall have the right to a grant of 2s. per month dating from the time when the child was begun to be nursed by her, up to the time when the child shall have reached the age of one year.

Ordered at Villiers-le-Duc. THE MAYOR DE VILLIERS.

While the number of cases in Villiers-de-Duc is too small upon which to accurately base inferences yet the information is most interesting.

It will be seen, as the essayist points out, that the essential features of the foregoing regulations are:

(1) They are orders to the people to do certain things and not merely recommendations or advice.

(2) Every mother with child has the right to adequate assistance in child-bearing.

(3) She is required to notify pregnancy.

(4) The midwives (they have midwives in France) are required to ascertain that the pregnancy is normal, and if not, so to notify the fact to the authority. For this service the midwife is paid out of the public funds.

(5) The authority pays whatever doctor the mother chooses.

(6) The authority has continuous supervision of and provision for the infant.

(7) The Regulations are complete; they deal with all mothers.

That the orders were obeyed are vouched for by the results.

While such regulations are at present scarcely applicable to this country they serve as a guide to indicate how good results may be obtained.

The regulations point out that the mother requires supervision by skilled advice before the birth of her baby; that she should have the services of a competent physician and careful nursing at her confinement, the expenses of which should, if necessary, be met by the State, and that the infant's life should be continuously supervised and provision made for its proper care.

Education of prospective mothers (and fathers too) is necessary in the prevention of infant mortality.

By the establishment of a Bureau of Child Welfare the Board has made a start in the right direction. The duties of this Bureau will be to conduct investigations in various communities in respect to infant mortality, to provide literature and advice to mothers in the care of their babies, and in a general way to be a source of help and comfort to anyone who may be in need of assistance in this important variety of life-saving.

Miss Mary Power, B.A., is in charge of this Branch.

Infantile Paralysis.

The extensive outbreak of acute Anterior Poliomyelitis in New York City occasioned some alarm in the Province. This with the smaller outbreak in Montreal, Quebec, was the occasion of adopting quarantine measures against the United States and the eastern provinces. We had a number of cases, happily not of the severe type, in Windsor and Ford City, but there was not at any time any real feeling of alarm in Ontario. A demand for information upon this subject, from both medical men and the general public, induced the Board to prepare a leaflet embodying some simple regulations and general advice. This is sent to all medical practitioners and to other persons upon request.

DEATHS IN ONTARIO FROM TUBERCULOSIS BY AGES, 1906-1916.

Year.	Total.	Ratio per 100,000	Under 5 years.					5–9	10–14	15–19	20–29	30–39	40–49	50–59	60–69	70–79	80 & over.	Not stated.	Total deaths from all causes.
			0–1	1	2	3	4												
	23,974		594	368	225	140	136	467	578	1,881	6,776	4,904	3,058	2,204	1,526	680	129	308	324,486
1907	2,530	113	74	41	27	20	15	44	62	206	745	499	311	227	173	64	9	13	31,756
1908	2,511	110	68	46	20	13	13	43	67	216	764	479	315	217	136	70	14	30	30,947
1909	2,380	106	47	27	25	9	15	54	54	179	687	487	290	222	163	66	15	40	30,792
1910	2,291	102	38	35	19	15	6	36	55	184	652	463	293	222	160	71	18	24	31,332
1911	2,353	92	63	30	15	10	18	48	64	181	618	476	325	218	156	85	12	34	31,878
1912	2,250	87	53	30	19	9	15	46	42	154	631	500	304	200	134	64	7	42	32,150
1913	2,294	85	52	36	20	10	18	32	41	188	632	479	313	204	156	56	10	47	34,317
1914	2,340	85	54	41	20	16	11	56	58	181	688	469	307	214	116	63	12	34	32,440
1915	2,466	89	79	39	25	19	16	55	74	168	676	515	273	242	176	73	15	20	33,294
1916	2,559	91	66	43	35	19	9	53	61	224	683	536	327	238	156	68	17	24	35,580

This Table Compiled by the Registrar General's Department.

CASES AND DEATHS FROM COMMUNICABLE DISEASES, REPORTED WEEKLY BY LOCAL BOARDS OF HEALTH FOR THE YEAR 1916.

Months.	Smallpox.		Scarlet Fever.		Diphtheria.		Measles.		Whooping Cough.		Typhoid.		Tuberculosis.		Infantile Paralysis.		Cerebro-spinal Meningitis.	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
January	21	......	152	3	297	42	3,018	59	136	10	35	8	140	68	1	1	21	17
February	34	......	165	2	223	13	2,793	35	268	9	259	19	166	85	......	......	26	15
March	32	......	252	11	265	23	5,158	47	283	13	74	24	182	120	......	......	34	20
April	8	......	185	1	197	17	3,206	44	140	14	36	11	178	124	......	......	23	14
May	10	......	120	7	170	7	2,980	14	160	10	60	12	175	82	1	......	7	4
June	44	......	121	2	165	17	2,039	14	135	7	35	7	153	86	2	1	11	9
July	9	3	80	9	179	18	1,234	8	179	8	76	9	143	82	20	3	14	10
August	5	......	37	......	183	11	243	......	190	7	190	18	103	69	44	5	20	15
September	......	......	30	......	266	35	94	......	181	9	196	17	151	78	76	7	10	8
October	6	......	73	......	362	35	248	1	253	1	127	14	141	64	31	7	12	9
November	1	......	85	......	467	28	515	3	91	4	74	11	132	56	10	2	8	1
December	4	......	149	4	438	38	449	2	189	5	63	8	149	70	5	1	9	7
Totals 1916	174	3	1,449	39	3,212	284	21,977	227	2,205	97	1,225	158	1,813	984	190	27	195	129
" 1915	626	2	1,415	29	2,719	169	9,684	107	882	51	920	96	1,356	774	13	4	139	105
" 1914	511	2	2,722	60	2,772	213	4,884	60	798	56	1,060	125	1,335	776	29	5	68	55
" 1913	774	2	2,746	101	2,194	233	7,895	134	484	84	1,519	213	1,576	1,040	35	20	61	48
" 1912	535	3	2,646	111	2,340	238	2,634	58	414	142	2,569	305	1,525	860	49	19	59	58

Only 40% of the deaths from Tuberculosis are reported weekly by the Local Boards of Health.

BIOLOGICAL PRODUCTS DISTRIBUTED FREE

By the Provincial Board of Health.

February 1st to October 31st, 1916.

Number of separate Municipalities receiving supplies, 539.

Smallpox Vaccine	26,985 points.
Diphtheria Antitoxin	120,224,000 units.
Anti-Meningitis Serum	1,310 x 20 c.c.
Tetanus Antitoxin	2,418,000 units.
Anti-Typhoid and Paratyphoid Vaccine	20,006 doses (civil).
" " "	467,541 " (Militia).

	Smallpox.	Diphtheria Antitoxin.	Diphtheria Antitoxin.	Anti-Meningitis Serum.	Intra-Spinal.
	Points.	Units.	Syringes.	Vials of 20 c.c.	Outfits.
February	5,910	41,169,000	3,550	476	208
March	5,225	16,367,000	1,224	180	44
April	3,405	8,154,000	329	212	50
May	3,485	12,275,000	384	117	28
June	2,795	5,928,000	479	87	10
July	1,830	11,029,000	325	98	19
August	1,430	8,211,000	663	94	17
September	1,625	6,803,000	792	31	11
October	1,280	10,288,000	914	15	5
	26,985	120,224,000	8,660	1,310	392

	Tetanus Antitoxin.	Tetanus Antitoxin.	Pasteur Preventive Treatment for Rabies.	Revenue for Special Containers.
	Units.	Syringes.		$ c.
February	991,500	208	....	845 20
March	141,000	54	2	275 40
April	174,000	23	....	92 90
May	243,000	41	8	97 60
June	93,000	16	6	103 50
July	127,500	25	13	78 55
August	273,000	62	5	152 65
September	177,000	19	13	167 15
October	198,000	29	1	190 85
	2,418,000	477	48	$2,003 80

Cost;

	$ c.
Smallpox Vaccine	1,079 40
Diphtheria Antitoxin	19,765 60
Anti-Meningitis Serum	1,605 40
Tetanus Antitoxin	820 80
Pasteur Preventive Treatment for Rabies	720 00
	$23,991 20
Revenue	2,003 80
Net cost	$21,987 40

THE DISTRICT OFFICERS OF HEALTH
PROVINCE OF ONTARIO

DISTRICT NO. 1.

Comprising the Counties of Lambton, Middlesex, Oxford, Elgin, Kent, Essex. District taken over temporarily by Dr. McNally in the absence on active service of Dr. (Major) D. B. Bentley.

DISTRICT NO. 2.

Comprising the Counties of Grey, Bruce, Huron, Perth, Waterloo, Wellington and Dufferin.

THOMAS J. MCNALLY, M.D.

District Officer of Health, Guelph, Ont.

I have the honour to herewith submit the Annual Report of Districts No. 1 and 2, comprising thirteen counties, for the year ending December 31st, 1916.

During the year the efforts of your District Officer have been directed especially towards an oversight of the water supplies of the larger towns and cities of the two Districts, and control of the communicable diseases.

Systematic regular visits to rural municipalities have been out of the question owing to the large area under supervision, but all calls for assistance or correction of insanitary conditions have been as promptly attended to as possible.

The frequent communications received is an indication of awakened public interest in conditions pertaining to public health through the Publicity Campaign carried on by the Department in recent years.

During the year the following cities and towns were visited and the condition of the water supply carefully gone into as well as the general sanitary conditions, viz.: Owen Sound, Guelph, Kincardine, Ingersoll, Chatham, Sarnia, Port Elgin, Stratford, Goderich, Galt, Tillsonburg, Woodstock and Windsor.

To several of these repeated visits were made and with the co-operation of Local and Provincial Boards of Health we believe serious outbreaks of disease prevented.

Three municipalities during the year have instituted control of their milk supply and two have appointed school nurses who are doing excellent work.

Fifteen municipalities, viz.: Kincardine, Forest, Clinton, London Tp., Arthur Vge., St. Mary's, Mersea Tp., Paisley, Mitchell, Port Elgin, Guelph, Kingsville, Mount Forest, Walkerton, Orangeville, Galt, and Drumbo were visited in connection with sewers and insanitary drains; in ten of these the conditions complained of have been corrected and in the remainder improvements have been made though not completed.

It is pleasing to note the improvements made in slaughter-houses and the interest manifested by the local authorities in seeing that these places are built and

maintained according to the Regulations of the Provincial Board, though I regret to say there are some municipalities not yet awake to their duty in this field.

Considerable improvement has also been manifested in the sanitary condition and surroundings of the public schools, especially in the rural districts, since the Local Medical Officers of Health have been required to visit these institutions at least once a year, but we are sorry to note that there are a number of municipalities in which there has not been much accomplished in this matter.

It is in our opinion one of the most important duties of Rural Medical Officers, and it is respectfully suggested that each officer be required to give a personal report on each school and its sanitary conveniences, well and surroundings in his municipality each year to your Board.

Communicable Diseases.

Smallpox.

During the year this disease has made its appearance in several municipalities, but has not in any case assumed the proportions of an epidemic, though in five townships and two cities it has required our personal supervision.

Scarlet Fever.

Has appeared in very few municipalities and has in every case been confined to a few controlled cases of mild type.

Diphtheria.

This disease is now under very good control owing to the wise provision of free antitoxin by the Provincial Board of Health, though occasionally appearing in severe form and thus claiming its victims through lack of its being brought under early medical observation and treatment.

Measles.

This year has been marked by very wide-spread epidemics of measles, there having been in the two Districts twenty-nine municipalities asking for and receiving assistance and supervision, either by correspondence or personal visits, to assist the Local Boards in controlling this disease. It is still our most difficult disease to control or prevent owing to its period of infectivity previous to a possible definite diagnosis and the apparent indifference of the public and we regret to say of some medical men in reporting early cases. The only apparent improvement in our methods of action for prevention and control would seem to be a rigid quarantining of all non-immune contacts for the period of incubation. We are pleased to note the shortening of the period of quarantine for this disease to two weeks, as this time appears to give the public ample protection and should materially assist in the better notification of the mild cases and observance of the quarantine regulation.

Typhoid Fever.

There was one outbreak of this disease due apparently to the milk supply and in other places isolated cases with about the usual percentage of fatalities, but the year passed without any serious epidemic.

Mumps and Whooping-Cough.

A few localities have suffered from the above disease, but in only two instances was advice or assistance requested. In case of the latter disease it would appear that a strict quarantine of those affected and non-immune contacts should be required for the period of infection and incubation respectively. It would appear that the period of isolation now required is excessive in view of recent observations by those apparently qualified to judge.

Tuberculosis: (Open Cases.)

In this disease lies the future great work of the epidemioligist if we recognize in a practical way the communicable nature of the disease as we should.

We fear its common occurrence, its insidious and gradual onset has, in a large measure, dimmed our proper appreciation of responsibilities and opportunities for effort in this field.

While some advance has been made in this Province in the care of those suffering from the disease and the consequent reduction of the number of its victims, there has not been that effort made by legislation to control, in an adequate manner, the spread of this horrible disease that its prevalence demands.

Its common occurrence and the magnitude of the problem of its control seems apparently so far to be greater than the capacity of our people to understand or the courage and initiative of our legislators to grapple with.

Were as may deaths as much distress, poverty and loss due to any other disease it seems to me proper and adequate control would not only be demanded by our people, but provided by those with the authority to legislate. It is quite true that the outlay would be great, but the results would be infinitely greater.

Rabies.

Two municipalities sought and received assistance and advice in controlling this disease among animals with the result that the disease was apparently stamped out.

Poliomyelitis.

One municipality sought and obtained advice and assistance in controlling infantile paralysis.

Cerebro and Spinal Meningitis.

In only one municipality was advice requested for this disease.

Correspondence.

Without going into details or names of municipalities concerned we may briefly cover the subject in this report by remarking that it involved about every conceivable subject and condition pertaining to sanitation and public health, and was of considerable volume requiring both time and effort to handle with satisfaction to our correspondents.

DISTRICT NO. 3.

Comprising Norfolk, Haldimand, Welland, Lincoln, Wentworth, Brant, Halton, Peel, York.

D. A. McClenahan, M.D.

District Officer of Health, Hamilton.

The year 1916 was largely taken up with the continuance of the educational aspect of public health work. Lectures were given in connection with the Public Health Exhibit provided by the Board, as well as addresses to Municipal Councils, Boards of Health, Boards of Trade and various institutes throughout the District for the purpose of furthering the work.

In addition, I visited a large number of the municipalities, amongst others being Dunnville, Hagersville, Port Credit, Milton, Simcoe, Port Dover, Brampton, Fort Erie, Niagara Falls. Upon receipt of complaints as to alleged nuisances in any of the several municipalities in District No. 3 they were always promptly investigated and a report forwarded at once to the office of the Chief Officer of Health.

There are a number of improvements that require to be made in different parts of the District, and they are improvements that the Councils realize the need of, but they hesitate to place additional burdens upon the people or to ask them to assume them on account of the numerous calls upon the citizens for patriotic funds and other worthy objects incident to the continuance of the great war. The money market is tight and the interest rate very high, and during the period of the war I have thought it wiser not to urge too strongly upon the various councils the expenditure of any but very reasonable sums of money until financial matters improve. We are hopeful, though, that with the incoming year peace may be once more restored to the Empire and that then we shall be able to pick up the loose threads of public health work and carry needed reforms to a satisfactory and successful conclusion.

On the whole, the year's work, while not spectacular, has been satisfactory and the foundation has been laid by means of educational and publicity campaigns for more advanced work in the ensuing year. After all the most important aspect of public health work is the educational aspect. We are trying to interest the people in the work and explain to them what we are anxious to have done and why we are asking for the reforms. We are doing this by means of articles to the press, addresses at different gatherings of the people, moving picture shows and in fact in any way that we can get the message to the people. We cannot always get results at once, but the effect of this educational progress will be felt in time and the desired results achieved.

I have always been a firm believer in the idea that we should begin to educate the children in matters relating to public health. Looking to this end I am urging on medical officers of health when they visit schools to give a talk to the children on how diseases spread—with special attention being paid to contact infection. I never fail to do this myself when visiting any of the schools—Public or High, Private or Separate.

As an instance of what some of the municipalities are doing I might mention the Town of Paris. At that place nothing had been done for a great many years. I have visited Paris a number of times and along with the very energetic M.O.H., Dr. Lovett, I think we have succeeded in arousing the citizens to the need of fresh effort in the public health line—the Sanitary Inspector at the same place is very efficient and is doing his best to have needed reforms carried out. The Town of

Paris has an excellent system of waterworks, the water being collected in galleries and pumped from the large well directly to the distributing pipes. There is also a large reservoir in case of special need. If the town had a proper sewage system and disposal plant, it would be a very pretty and up-to-date place. In the meantime, a good deal of the sewage finds its way in one way or another into the Grand River. There are a number of stores on the main street that are quite close to the River and the closets at the back of the stores are so close to the water that there is no way of cleaning them except out through the stores to the front street. Consequently they are usually cleaned by the contents being thrown into the River. In some places the closets are over the water, and when used the contents fall directly into the River. I have recommended that a sewer be put in on the main street, and that the closets be changed into those of the water carriage system and connected with the sewer—then the contents of the sewer could be treated by a septic tank and not allowed to go into the river in a raw state. This is the plan the Council are seemingly in favour of adopting. In the meantime they are collecting garbage and night-soil and are having manure receptacles installed as fast as workmen can be got to do the work. This is one instance of the work we are trying to do, and many more examples might be added.

DISTRICT NO 4.

Comprising the Counties of Prince Edward, Hastings, Northumberland and Durham, Peterborough and Haliburton, Ontario, Victoria, Simcoe and Muskoka.

Geo. Clinton, M.D.

District Officer of Health, Belleville.

I hereby beg to submit my fourth annual report (condensed) for my District during 1916.

Detailed reports have been regularly sent to the Health Department.

During the year I have visited thirty-one towns and villages, fifteen townships, ten hospitals, six gaols, five asylums, eight houses of refuge, five armouries, four children's shelters. In many places several visits were made to assist the local authorities in special work.

Many places, after a thorough survey the previous year, could be attended to by correspondence with local boards.

County Councils.

In January I met and addressed the County Councils of Simcoe, Ontario, Victoria, Northumberland and Durham, Peterborough and Prince Edward.

Kawartha Summer Resorts.—Kawartha Lakes, Viamede.

Stoney Lake.—Mt. Julien, McCracken's, Kawartha Park, Glenwold, Burleigh Falls.

Buckhorn.—Buckhorn House, The Windsor.

Muskoka Lake.—Beaumaris, Milford Bay, Roseneath, Hutton House, Cedar Wild, Scarcliff, Ross Clair, American House, Swastika, New Windsor (at Bala).

Lake Joseph.—Prospect House, Pt. Sandfield, Elgin House, Pinelands, Belmont, Hamills Point, Staney Brae, Barnsdale (condemned), Gordon Bay House, Dickenson House, Stanley House.

Lake Rosseau.—Nepahwin, Woodington, Cleveland House, Chiltona House, Paington House, Thoril House, Morinus, The Bluffs, Royal Muskoka, Earnscliff, Maplehurst, Rossmoyne, Monteith House, Rostrevor, King's Park, Waskada, Maple Leaf House, Fife House, Windermere, Ingleside.

Port Carling.—Port Carling House, Beverley Lodge, Algonquin, Oak Crest.

Sparrow Lake.—Methodist Mission, Roehl House, Vanomi, Mount Royal, Franklin House, Delmonte, Wiancko, Lake Shore House, Sparrow Cottage, Stanton House, Winona, Uneeda Rest, Lake View, Idle Wyld, Peninsula Farm.

Georgian Bay.—The Royal, Victoria, Cottage Resort, Point Pleasant, Winseaona, Go-Home Bay, Franceville No. 1, Franceville No. 2, Whalin Island.

Lake of Bays.—Pine Grove Inn, Nor Lock Lodge, Dwight House, Gouldie House, Britannia, Point Ideal, Point Cunnington, Island View, The Hemlocks, Ronville, The Narrows, Gonoseyo, Bay View Farm, The Maples, Garyowen, Wa Wa, Glenmount, Grand View, Burlmary, Langhton House, Idle Wyld, White House.

Presque Isle.—A summer resort near Brighton. Closets mostly all crude and no proper disposal of garbage. I called a meeting of the cottagers and had a committee appointed to see that improvements would be made. The L. B. H. and M. O. H., Dr. Wade, was with me and fully approved of my suggestions.

Muskoka Steam Boats.

	Septic Tanks.
Sagamo	2
Medora	2
Cherokee	2
Kenosha	1
Islander	1
Ahmic	1
Oriole	None.
Charlie M	"

The Government boats at Peterborough have septic tanks. Young's boats have promised to have tank for 1917.

Public Institutions.

Asylums.

Cobourg, Whitby, Orillia, Penetang.

Colleges and Schools.

Hastings 8, Northumberland and Durham 6, Peterborough 4, Prince Edward 2, Simcoe 8, Victoria 4, Ontario 5, Muskoka 3.

Factories.

Factories of different kinds all have made an effort to comply with the regulations, more especially the canning factories, and now conditions in general are much improved.

Hospitals.

Oshawa, Belleville, Cobourg, Peterborough 2, Peterborough Isolation, Orillia, Barrie, 1 Isolation for troops; Collingwood, 1 Isolation for communicable diseases; Port Hope, a new building, very modern; Bowmanville, Lindsay, 1 Isolation.

Armouries.

Oshawa, Cobourg, Peterborough, Lindsay and Arsenal, Belleville, Barrie.

Communicable Diseases.

Measles.

No severe epidemic but isolated cases in whole district, except a mild outbreak at Wooler. Special visit to Wooler. These cases are not properly reported, due to laxness of parents and physicians.

Whooping Cough.

Several cases but not reported or quarantined.

Scarlet Fever.

No epidemic; a few isolated cases.

Diphtheria.

No epidemic.

Smallpox.

No epidemic.

Typhoid Fever.

During the month of February about 20 cases of typhoid in Belleville and four deaths. After a thorough investigation it apparently was due to contaminated water supply. Mr. DeLaporte was with me, and with the hearty co-operation of the Local Board of Health chlorine tanks were installed and the disease was stamped out.

Special Visits.

Lindsay *re* complaints about armouries. I found everything in good sanitary condition.

Visited Picton in September *re* ice cream parlor, where there was an epidemic of gastro-enteritis among those who had been eating the ice cream. The factory was scrupulously clean and was unable to locate the cause. Had several samples of milk tested. Result negative.

Special Oshawa.—*Re* waste from tannery and woollen mills. Since these visits settling tanks have been constructed. Several cases of anthrax among cattle and the Dominion Veterinary Surgeon has taken charge. One man contracted the disease and died. Another man recovered who had contracted the disease.

Corby Distillery.—Two visits as they were polluting the river by waste from stables, etc. Gave them notice and the manure was all removed without delay. All the alcohol manufactured was being used for munition and the waste from distillery was the washing from grain, mostly flour water. This is a nuisance, but it is a question if injurious to health. Under the circumstances did not feel justified in closing them up.

Trenton.—*Re* blocking drain causing private cellars to be flooded.

Deloro Cobalt Smelting.—By request of the company for advice to make the place more sanitary.

Wooler.—*Re* epidemic of measles and whooping cough.

Special Gravenhurst.—Inspected the four sanitariums and found all satisfactory except the Minnewaska. Here the water supply was not sufficient and the septic tank and tile was broken so that the discharge was going in a small creek leading down into the lake. At that time there was about 80 returned soldiers with tuberculosis. Septic tank was built to accommodate about 40, hence the overflow. My visit to the Minnewaska was in November.

I observe a marked improvement in my whole District. A lack of properly trained sanitary inspectors, and those employed have many other duties and are poorly paid, which is a great drawback. Many of the Medical Officers of Health practically act as Sanitary Inspectors, which should not be necessary if competent Sanitary Inspectors were employed.

DISTRICT NO. 5.

PAUL J. MOLONEY, M.D.

District Officer of Health, Cornwall.

I hereby beg leave to report concerning the duties performed by me as District Health Officer No. 5 District, during the year 1916.

AREA AND POPULATION.

This District comprises the Counties of Lennox and Addington, Frontenac, Leeds and Grenville, Dundas, Stormont and Glengarry, Prescott and Russell, Carleton, Lanark, Renfrew and the City of Kingston.

It has a population of 326,958.

The population is very largely British born, except in the Eastern part along the Ottawa River where French-Canadians predominate.

CONTAGIOUS DISEASES.

During the year there were less contagious diseases than in recent years. We still traced many of our outbreaks, however, to the mobilization of the troops at different points and the consequent travelling to and fro.

Smallpox.

Generally mild in character, and owing to this hard to control. Another result from those recent mild outbreaks, was that many persons strongly objected to vaccination. One influential newspaper in this district unfortunately is a pronounced anti-vaccinationist.

Harrowsmith, Olden, Kennebec, Hinchinbrooke, Sharbot Lake, and Calabogie.

The outbreak in all these may be referred to together. The outbreak began probably at Harrowsmith in Portland Township, County of Frontenac. It was mild in character and before being clearly recognized had obtained a good hold all along the Kingston and Pembroke Railway as far as Calabogie.

Good work was done by Dr. Geddes, of Verona; Dr. Barker, of Parham, and Dr. O'Reilly, of Calabogie, Health Officers, in stamping out the epidemic.

Elgin.

A sporadic case occurred near Elgin, Leeds County, and was well handled by Dr. Dunn, M.O.H.

The means used in stamping out the disease in all cases were quarantine, vaccination and disinfection.

Infantile Paralysis.

A few cases, evidently sporadic, of this disease occurred, one each at Elgin and St. Albert, and two in Rockland.

Typhoid.

The number of cases of this disease were much below normal throughout the district except at Smith's Falls, where we had two very severe outbreaks, one in June and one in August and September, each of which were due to a different infective source.

June epidemic, 18 cases. All these cases occurred in railroad men who were using as a drinking water supply the water from the Whitehead well near the roundhouse. The water from this well tested badly and had within 30 feet an outdoor closet available to the public use.

By eliminating other possible sources of infection and reasoning from the fact that there were no other cases in the town for many months, or during the outbreak no additional cases in the homes of the men affected, there remained no doubt that the water from this well was the immediate cause of the outbreak. The well was closed, the patients removed to the hospital and the epidemic ceased. Anti-typhoid inoculation was strongly advised and was used by large numbers of the citizens.

After the June outbreak had cleared up, a sudden virulent outbreak occasioning many deaths and probably a hundred cases occurred in August.

Mostly every one of the cases occurred in people who had been using, for a drinking supply, water from a well known as the "French Hill Well." This was a bored well near a street corner, on each street was a sewer. The well was ordered closed. A regular systematic test was then made of all the wells in the town. The town is built on a bed of shelving rock, and as all the sewers are built through rock, and as they are never watertight, and as there are very many outdoor closets, it was easy to understand why a great many wells tested badly. Mostly all the wells are now closed and sufficient chlorine is used to render the municipal water supply safe. A water filtration plant was again strongly advised. This is one of the situations where a municipal supply generally known to be contaminated was abandoned by ratepayers for a still more polluted well water supply. This town was advised some years ago that filtration of the water was advisable, but the authorities pleaded their inability to finance the needed improvements.

To control any further epidemic a system of chlorination was installed for the water supply. The citizens were directed to boil all water used for drinking purposes. A general cleaning up was ordered and carried out.

A by-law was passed by the Town Council which practically did away with all outdoor closets.

The milk supply was carefully looked into and the milk depots ordered to be more carefully screened and otherwise protected from flies.

The epidemic was cleaned up in about six weeks.

NOTE.—Dr. Easton, the M.O.H., and the Local Board acted most energetically during the outbreaks. Water supply chlorinated after second outbreak.

Lower Ottawa River towns, as Rockland and Hawkesbury, had about the usual number of cases, typhoid being endemic there, as they use the untreated Ottawa River water for drinking purposes.

Scarlet Fever.

Not so many cases as in 1915. The disease was pretty wide spread, however, and was of a mild character.

Diphtheria.

Not many cases reported, no epidemic except at Rockland where it is endemic.

Measles.

Widespread but rather mild.

HEALTH EXHIBIT.

To promote and interest in Public Health work and for instructional purposes, the Provincial Board sent the Public Health Exhibit into the district. Judged from the attendance and the interest taken in the meetings, it was a great success.

Over thirty thousand attended the different meetings, which owing to the restricted size of the public halls, generally required from two to three meetings at each place.

The locations visited were Rockland, Smith's Falls, Perth, Pembroke, Eganville, Renfrew, Arnprior, Casselman, Vankleek Hill, Hawkesbury, L'Orignal, Westboro, Eastview, Almonte, Carleton Place, Morrisburg, Iroquois, Cardinal, Prescott, Chesterville, Winchester, Cornwall, Gananoque and Napanee.

The Grand Trunk Railway Co. kindly loaned two films of Canadian views which were well received.

Correspondence.

Most of the Local Health Officers and Boards of Health and many others consulted the office frequently with regard to sanitary matters, over 800 letters being sent out.

Special Conditions Dealt With.

The Town of Rockland has one of the highest death rates in the Province. Typhoid and other contagious diseases seem endemic there. The water supply used by the people is drawn from the Ottawa River and used untreated. It is a lumber

town in the sense that the only manufacturing establishment is a large lumber mill. I have visited this town more frequently during the year than any other locality in my district. I have not had very much success, but I hope that by means of Public Health lectures, the locating here of a visiting nurse, and the filtration or chlorination of the water supply, to do better in the future.

Westboro.—A condition exists above the City of Ottawa and along the Ottawa River which is a constant menace to the health of the inhabitants and also to the City of Ottawa. Some 10,000 people are scattered along a few miles without sewers or municipal water supply.

In many cases very primitive accommodations are supplied but in most cases an attempt has been made to have modern conveniences. Resulting from this general condition the water supply of the people themselves is constantly menaced, while from their situation on the river they are a constant danger to the Ottawa City Municipal supply.

I have inaugurated a campaign in conjunction with the Health Officers of Ottawa and Westboro to abate the above conditions, which I trust will be successful in the near future.

Pembroke Water Supply.

The Town of Pembroke has installed a water supply at considerable expense for a town of this size.

The intake some years ago was greatly extended until now it is perhaps the longest intake in Canada.

Twelve miles above and on the river is the big Petawawa Military Camp.

The camp has a water and sewage disposal plant of its own.

It has been a burning question for years with Pembroke the manner in which the military authorities conducted the sewage disposal plant. I frequently inspected this disposal plant and whether from not being of sufficient size to take care of the work expected or from want of care in its operation, the results achieved were not satisfactory. During July, 1916, when owing to the large military camp the plant was greatly taxed, matters got much worse and eventually the beds refused to work.

The military engineers had foreseen that the plant would not be adequate and had prepared a new unit. This unit was not properly constructed and proved of little, if any, assistance in taking care of the sewage. Eventually the sewage was allowed to run in an untreated state directly into the river.

Representations were immediately made to the military authorities in Ottawa and no redress being forthcoming, the Provincial authorities were appealed to. This was effective and for the balance of the season the sewage was fairly well taken care of.

The Town of Pembroke will watch jealously any laxity of the authorities at the camp in the future.

Other conditions in most cases requiring at least one personal visit:

Carleton Place.—Dispute, *re* presence of livery barn too near a dwelling.

Glen Nevis.—Improper interment in a cemetery.

Perth.—House of Refuge.

Smith's Falls.—Nuisance caused by swale above the town.

Brockville.—*Re* garbage disposal plant.

Lansdowne.—Complaint, *re* river cottages.

Cardinal.—Nuisance caused by certain ditches.

Westport.—Sewage system.

Gananoque.—Complaint *re* river cottage.

Elgin.—Nuisance *re* cesspools and unsanitary dwellings.

Augusta.—Tuberculosis in schools and the closing of the schools from this cause.

Prescott.—Buckley Estate nuisance and sewage by-law.

Napanee.—Suit, *re* removal of nuisance and sewage disposal plant.

Casselman.—*Re* appointment of M.O.H.

Rockland.—Sewage nuisance, water supply, etc.

Renfrew.—Water supply.

Petawawa.—Nuisance, piggery.

Pembroke.—Water supply, slaughter houses.

Osnabruck.—Selling diseased meat.

Cornwall.—Establishment of Isolation Hospital.

Ottawa.—Mica factory nuisance, water contamination, etc.

Westboro.—Water and sewer questions.

East View.—Extension of cemetery, slaughter houses, ice cutting, etc.

Winchester.—Establishment of sewage system.

Morrisburg.—Contamination of sewers.

Iroquois.—Sewers.

Harrowsmith.—Dispute, *re* M.O.H. salary. Smallpox.

Kaladar.—Unsanitary premises.

Kingston.—Unsanitary dwellings, overcrowded dwellings, etc.

Besides the above, all public institutions, such as Asylums, Penitentiaries, Hospitals, Houses of Refuge and Homes, Orphanages, and County Jails, were carefully inspected and a full detailed report made to the Provincial Board of Health.

Military Work.

For a short period owing to scarcity of sanitary specialists, I had charge of sanitation at the artillery camp at Petawawa as assistant director of Medical Services.

Afterwards I was able to render considerable service by aiding in and examining recruits and looking after the sanitation of many of the frontier guard posts. These latter services were rendered gratis to the military authorities.

DISTRICT No. 6.

Comprising the districts of Nipissing, Parry Sound, Sudbury, and Temiskaming.

W. Egerton George, M.D.

District Officer of Health, North Bay.

I have the honour to submit for your consideration the fourth annual report of District No. 6 comprising Nipissing, Parry Sound, Sudbury and Temiskaming.

During the year I travelled 28,267 miles at an expense to the Department of $1,055.21. Of this mileage 16,913 was within this district and the expense incurred therewith was $769.77.

In visiting the different municipalities during the past year, appointments were made to meet the Health Officials and Boards of Health as formerly as an invitation was almost invariably the inspiration of the visit. By meeting the Health Officials it was usually possible to locate their difficulties and to assist or advise in a solution. Indeed, it is to be regretted that so large a part of my time is occupied in satisfying municipal requests since there is reason to believe that many serious matters are being overlooked because of lack of time to make sanitary surveys of a more complete character. I have been aware that several small municipalities required my attention in the way of encouragement and assistance to arouse them to the seriousness of the menace in their delapidated privies; but it was impossible to get to them in time to get anything done last season.

Communicable Diseases.

During the past year I received these returns of the following diseases.

	Cases.	Deaths.
Typhoid	221	22
Diphtheria	48	2
Measles	586	9
Tuberculosis	6	12
Scarlet Fever	35	0
German Measles	6	0
Whooping Cough	11	9
Meningitis	2	7?

It is very probable that five of the meningitis deaths were intended to mean deaths from all other causes as they were all reported on one card on April 6.

Every indication that but little attempt is being made to report the tubercular cases is evidenced by the fact that we have had twice as many deaths reported as cases for the year, which I think you will agree is far from the degree of perfection desired.

It is quite apparent that Health Officers are not recognizing the seriousness of whooping cough. There were nine deaths from this disease; its total being surpassed only by typhoid and tuberculosis and yet but eleven cases were reported. Undoubtedly there were many hundred cases. Surely it is advisable that a stricter quarantine be maintained over this disease.

There were three important epidemics of measles at Copper Cliff, Parry Sound and Burk's Falls. One hundred and sixty-three cases were reported from Copper Cliff with four deaths; eighty-six from Parry Sound with two deaths; one hundred and six from Burk's Falls with no deaths. I visited Burk's Falls and Parry Sound during the epidemics. In each of these towns the difficulty was in getting reports of the cases before the rash. It is to be hoped that by sending all children home from school who show the slightest throat irritation and cough, and by reporting them to the Medical Officer that considerable control may be maintained over the disease.

Of the 221 cases of typhoid, 187 of these occurred in Parry Sound; and of the 22 deaths, 19 occurred in Parry Sound. A large proportion of the remainder undoubtedly got their infection here and carried it to the neighbouring communities. The outbreak was purely a water-borne epidemic. It is noteworthy that as District Officer I had pointed out the danger of this water supply in 1913 and urged action on the part of the council but without success. I then had the Chief Officer take the matter up. He had the sanitary engineers of the

Department make a report which made the gravity of the condition more apparent. With this additional evidence it was still impossible to get action on the part of the council. Shortly after the epidemic began in the early part of the year a chlorine plant was installed but there was evidence of inefficient management. They apparently seemed anxious to correct any leakage but I feel certain that the supervision of this plant was very weak as the disease remained all year with the exception of June and July. In August after the summer vacation there was another outbreak with eight cases within the month, in September ten cases and in October eleven. I am convinced that if this plant is run efficiently full control of the water infection can be maintained. Vaccination was recommended and tried but it was impossible to get second inoculations. The sudden rise in the incidence of the disease during the fly months (August, September and October) was carefully noted. This seemed to throw important stress on the insanitary privy. An effort was made to correct this but with little encouragement. When the Sanitary Inspector took police court action against certain people for not complying with his orders to construct fly-proof privies, the case was dismissed with a warning. A more serious and discouraging state of affairs could hardly be imagined; and it is little wonder that progress was small. I have offered personal assistance in prosecuting these cases but an arrangement has not yet been arrived at.

An extension of sewers with compulsory connection is urgently advised as a means of getting rid of a number of their open closets.

The weekly reports of communicable diseases which you have been forwarding for the past two years have been of much service in keeping tab on the location of epidemics; and where information *re* epidemics come from other sources we are able to ascertain by the presence or absence of these returns whether the secretaries of Local Boards are neglecting this duty. By this means I have been able to locate several municipalities from which no returns have been received and others where they were very incomplete.

It is a matter of regret to the District Officers that they are not able to show statistical evidence of a decreasing death rate from preventable causes. The importance of conserving our infant population is impressed upon us by the enormous sacrifice of Canadian lives on the battlefields of Europe. Facts regarding the decrease in the number of epidemics, the number of cases and the number of deaths can only be shown by having access, also, to birth and death returns. I would, therefore, strongly recommend that the District Officers be provided with all birth and death returns for their respective districts. If the original cards are not filed in the Department, I would advise that these be forwarded along with the weekly returns of communicable diseases.

Water Supplies.

A number of municipal supplies are rapidly becoming grossly polluted by the number of cottages which are being built on the shores of the lakes which constitute these supplies. This is particularly the case with North Bay and Sudbury. The Mattagami river from which Timmins obtains its supply is becoming polluted by the number of camps above their intake. I have recommended chlorination. The Iroquois Falls drinking water is similarly polluted but they have a chlorine plant already in operation. North Bay urgently needs the protection of a chlorinating system. The danger of this supply has been ably pointed out by the Local Board of Health. Each year the pollution has increased; this

year seven cases of typhoid developed. It is to be hoped that the Local Board will ask for a mandatory order to force the installation of such a system before another season. Sturgeon Falls was ordered to provide this protection but I believe that this order was ignored. Further remarks regarding Parry Sound supply would seem superfluous.

Sewers and Privies.

I was asked if the building of a sewer at Smooth Rock Falls would be permitted but explained the impossibility to allow any work which did not include a disposal system. Timmins is also contemplating the building of a sewer but as their out-fall would be into the Mattagami river above the intakes of the towns of Jacksonboro and Smooth Rock Falls they were notified that a disposal system must be constructed before sewers would be allowed to discharge into the river. Those asking information of this kind were told to submit all plans and specifications to the Provincial Board before proceeding with any of the work.

In Parry Sound, Cobalt, Haileybury and New Liskeard where the condition of the privies is very poor the extension of their sewers and compulsory connection is very desirable. An effort at the standardization of these out-houses and the regular collection of the night-soil has been repeatedly advised. The Local Board in Haileybury took the matter up and sent a recommendation to the council, but allowed it to drop there.

North Bay is slowly proceeding with their trunk sewer which when complete will provide new connections for nearly a fifth of the population.

Parry Sound has had engineers at work providing a comprehensive scheme which they will be able to build to.

Dairies and Milk Supplies.

Towns and villages of less than three thousand population have difficulty in getting a reasonably good supply of clean milk. Rarely is the dairy inspected or the milk tested for dirt. If, however, these dairies are supplying any of the larger towns they are maintained at a fair standard by the inspection of the officers of these towns. This is undoubtedly the case at Powassan. The dairies at Parry Sound, Burk's Falls, and Englehart produce almost invariably the dirty product mentioned above. In some few instances the dairymen have taken the initiative and introduced pasteurizing plants, provided modern equipment, tested cows for tuberculosis or constructed their byres on the most approved plans. Such effort should be rewarded and I have strongly recommended certain Health Officers to have their dairies scored and thus give such endeavour all the encouragement possible. If the milk of some of the poor producers was put into the poor grades where it belongs, unfair competition with high class milk and high class producers would be removed. As long as this poor product can be sold to an uninformed public as quality goods poor dairies will be the rule rather than the exception. Since the National Commission on Milk Standards have given us a sound and reasonable method of grading, no exception can be taken to it by the dirty producer.

North Bay, Sudbury, Cobalt, Haileybury and Timmins could adopt this method with much advantage to the public and to the high class dairymen.

In New Liskeard, Haileybury and Cobalt, insufficient attention is given to the dairies to maintain a reasonably clean milk. The lack of inspectors who will take an interest in this work seems to explain the weakness.

Sanitary Inspectors.

I have continued to point out year after year the incompetency of Sanitary Inspectors which is largely due to the out-of-date method by which they are appointed. Councils continually show a lack of interest and care for the health of the community by the appointment of men without the slightest qualifications for the position. They are willing and even anxious to use this position as a means of bestowing charity. The only credit that the councils deserve is that the case selected is usually deserving of charity. New Inspectors are appointed each year or for a few months with the result that they do not become familiar with what constitutes a nuisance let alone the sanitary needs of the municipality.

Undoubtedly it is the greatest affront to that Board upon which devolves the duty of caring for the health of the community to provide it with such poor tools with which to carry on the work. Surely it would be better that Sanitary Inspectors should be appointed by the Board of Health and continue in office subject to the pleasure of this body. In this manner the spectacle of one of these wards of the municipality making his report to the council, or to certain of its members who have shown such splendid capacity for weighing matters important to the town's health, instead of reporting to the Health Officer and Local Board who are qualified to dedicate reports of such to the waste basket where they belong, will be done away with. The mention of examples of this condition might better be left to private interviews; suffice it to say that they exist in this district.

DISTRICT NO. 7.

Comprising the districts of Kenora, Rainy River, Thunder Bay, Algoma, Manitoulin and Patricia.

Dr. R. E. Wodehouse, Major Canadian Army Hydrological Corps. On active service. District taken over by Dr. George.

Report of Provincial Sanitary Inspector

GEORGE E. YOUNG.

PARRY SOUND SANITARY CONDITIONS.

MARCH 11TH, 1916.

I paid a visit to Parry Sound this week, and learned from the Town Clerk that one hundred and sixty cases (160) of typhoid fever had occurred, with several deaths, since January 1st; am not at all satisfied with the situation there.

The Town has a population of between three and four thousand, which has been increased by the addition of 2,600 workmen, for the establishment of the munition works at Nobel, and very little increased housing accommodation has been provided.

A chlorinating plant has been installed to remedy the water supply, but nothing has been done in the way of cleaning up the numerous boarding houses. A number of them are too filthy for human habitation, and with an air space of from 131 to 240 cubic feet per person.

Last fall, Dr. George, District Officer of Health, and I tried to impress upon the Council that it was imperative to appoint a Sanitary Inspector for that work alone instead of being combined with the duties of Chief of Police. No change has been made so far.

The promised scavenger and garbage by-laws have not been completed.

As the situation stands at present the fever is spreading to the surrounding country, and if a new leaf is not turned over shortly, we will have a situation similar to Cobalt in the early days.

Dr. C. T. Denfield, the retiring Medical Health Officer, stated the other night that conditions were favourable for a serious outbreak of measles also.

I think the situation in Parry Sound is so critical at present, that if a whole-time Sanitary Inspector is not appointed by the Council, the Provincial Board should recommend the appointment of one by the Lieutenant-Governor in Council.

MARCH 27TH, 1916.

Visited Parry Sound the latter part of last week. The Town Clerk informed me that only three cases of typhoid have developed since the 3rd of March.

A scavenger and garbage by-law has now been passed and tenders advertised for. It will not, however, be possible for it to become operative till possibly the 10th of April.

I have thought of going down there for a week to assist the new Sanitary Inspector who is starting his duties next week.

Fortunately, the measles have not increased very rapidly, and the situation is now handled by Dr. Mason, the new Medical Health Officer.

Extra accommodation will have to be provided, when the warmer weather arrives, for the large increase of population. It is reported that the Nobel people are going to build fifty houses for their employees. If they do, it will be a great benefit.

April 10th, 1916.

Visited Parry Sound last week and accompanied their new Sanitary Inspector, Mr. O. J. Crockford, on the rounds of his duties.

A scavenger by-law (similar to that for Sudbury) has been passed, and the contract for performing this work let to E. J. Roach, of North Bay, who, I am confident, will organize the work for them and do it efficiently.

With the object of obviating an increased development of typhoid fever, when the flies arrive, we have notified in the neighborhood of one hundred and fifty boarding-houses, restaurants and private houses to clean up. A number of the premises we found in a very filthy condition.

As their incinerator is not very efficient for burning night soil, the Town purposes securing a sandy place, about two miles out of town, where they will trench the surplus matter; this, of course, will be located where it is impossible to contaminate any waters, etc.

May 16th, 1916.

Although the typhoid fever epidemic in Parry Sound has been abated by using chlorine in the water, I have been afraid of the danger of a further outbreak when the flies arrive.

I visited Parry Sound, therefore, again during the last week, re-inspecting certain premises and taking sedimentation tests of milk and inspecting the dairy barns.

There appears to have been so little sanitary supervision in the past, that when their Sanitary Inspector gave owners of premises notice to clean up, in some cases no attention was paid to the order. Some discipline appeared necessary, so Sanitary Inspector Crockford laid informations against seven of the worst offenders, and secured five convictions. Mr. Taskey, Crown Attorney, took charge of the prosecutions. On acount of the sickness of the Police Magistrate, Messrs. J. C. McLean, J.P., and Mayor J. Dwier heard the cases.

Speaking of prosecutions, I wish to mention an incident that occurred. A man had a number of hogs penned less than 100 feet from a dwelling. The pens were very filthy (all of which the Inspector and I proved), and, while Mr. McLean was for conviction, the Mayor told the Court he would not convict on our evidence (*i.e.*, evidence of Sanitary Inspector) without complaint from other citizens, despite the fact that Section 73 of the Act and Section 20 of Schedule B. were called to his attention.

We made nine sedimentation tests of milk from the different dairy barns, and found five samples fair and four very dirty.

None of the dairies visited showed conditions (construction of barns or the nature of appliances used) conducive to the production of clean milk. Instead of going to the Medical Health Officer and having their dairy and other premises inspected for a license, dairymen have been allowed to pay the Town Clerk twenty-five cents and secure licenses without any further ado.

December 11th, 1916.

While in Parry Sound last week I had their Sanitary Inspector accompany me and visited several places in town, and also their public dumping ground.

While there is much to be desired yet in the way of sewage disposal, etc., wonderful changes have been made for the better in the past year, and many residents are learning to obey the sanitary by-laws.

The Medical Health Officer reports that no new cases of typhoid fever have occurred in the last six weeks, something very unusual at this time of year for Parry Sound.

BEAR ISLAND—MEASLES.

SEPTEMBER 26TH, 1916.

Bear Island is situated sixteen miles up the river from Temagami station, on the T. & N. O. Railway; it has an area of six and one-half miles, where thirty-two families reside, making a population of 136, of which 52 are children.

I found that 45 of the 52 children had the measles lately. Two deaths had occurred among the children, but as there had been no physician in attendance, it could not be learned that measles were the cause.

About one half of the inhabitants are Indians, who, in the absence of any person in authority, mingle with and travel around among the people on the islands, spreading the disease very rapidly, so I quarantined the whole island and secured two constables to keep them within the bounds.

I made arrangements for the few American tourists left, to leave without coming in contact.

The inhabitants will get their supplies as usual at the Hudson Bay store on the island.

I would suggest that Mr. H. G. Woods, Hudson's Bay Factor, be appointed a registrar of vital statistics, as he is in touch with the whole district.

When here I discovered a case of measles in Temagami, and, as the family had no way of isolating the patient, I quarantined the whole family, securing a man to serve them with the necessaries.

OCTOBER 14TH, 1916.

Quarantine for measles at Bear Island, Temagami Reserve, was raised on Monday the 9th instant, and the premises disinfected. There have been no further deaths since my last report, and with the exception of some minor matters the patients seem to have recovered nicely.

The total number of cases as near as could be estimated were two adults and fifty-one children, making a total of fifty-three. All the rest of the inhabitants are reported to have previously had the disease. One of the constables I had looking after the quarantine got the chance of higher wages, and left the island against my express orders. He has now billed me with the time he put in, which I have refused, and feel disposed to prosecute him for breaking quarantine.

SANITARY CONTROL, NORTH BAY WATER SUPPLY.

OCTOBER 16TH, 1916.

The source of water supply for North Bay is situate in an adjacent municipality over which North Bay has no sanitary control. Effort on the part of the town to obtain sanitary control of the area has been opposed by the Township of Widdifield and the summer residents. During the last year several cases of typhoid fever have been traceable to the water.

It seems that North Bay has offered to do the scavenger work of a portion of the Township free if the Township will make certain improvements and have the district cleaned up, but the Township has neglected to do anything. By

resolution passed at the last meeting of the North Bay Council they asked me to make a sanitary survey of the water supply area and take such action as would compel Widdifield Township to cease polluting the town water supply.

Last Wednesday I made an inspection and reported to the North Bay Council, stating I would take such further action as you may advise. The report under date of October 14th, 1916, is as follows:—

Gentlemen,—In compliance with a request from your Town Clerk, and accompanied by Messrs. Alex. White and Malcolm Angus, Sanitary Inspectors for the Town of North Bay and Widdifield Township, respectively, I made a sanitary survey of Trout Lake from which the water supply for the town is taken.

We started at the source of Lee Creek and followed it over a mile to its outlet in the north-east bay below the station. Then we followed a small stream coming in near the same spot and running back towards the Lounsbury road. We also visited nine summer cottages between there and One Mile Bay. Coming back to the Smelter property I inspected all the properties, including the two mills, and to a distance of 500 feet south from the lake at this point, also Hughes and Kettle Islands.

Lee Creek runs through a farming district where animals have free access, and is also a watering place for teams where the road crosses near the mouth. Quantities of animal excrement reach the water supply from this source, also both human and animal excrement enters from the small stream further up where I found a pig pen, two pit closets, and dirty premises—all within easy drainage of the water supply.

The nine cottages visited in the Park were all unoccupied, but from location, construction and care taken, I do not believe any serious pollution would reach the water supply from them. Starting at the Smelter property going south between the T. & N. O. Railway and the lake, I found nineteen closets. Six of them were pits, one chemical, five pits uncleaned with cans, and seven clean with cans.

With the exception of five, the closet buildings were entirely unfit for the purpose intended. Some of them were built over unemptied pits with merely a wooden floor with the cans set on top. In this district we also found three stables with large accumulations of manure, some of which had been there for years.

The buildings and stables are all at considerable elevation above and situated near the lake, and their drainage can be traced to the water supply.

The two Mills should have some sanitary system, for use of the men, established where it is convenient, as considerable pollution must reach the lake from the excrement of careless or indifferent employees.

There is no burner at the sawmill, and large accumulations of sawdust, etc., are deposited in and around the lake at this point.

In passing up and down the T. & N. O. Railway this summer, I noted that the water lot owned by the Corporation of the Town of North Bay was generally nearly covered with logs, and on examination last Wednesday, I found the bottom of lake at this point covered with bark and other debris.

In the district from the Smelter going south and adjacent to the water supply, the only evidence of sanitary supervision is that iron buckets were placed in some of the closets, and these had evidently been emptied lately; with this exception the conditions were very unsanitary.

My reason for emphasizing the Smelter area is, that I believe the bulk of the pollution reaching the water supply is from this point, and that the Municipality of Widdifield has been negligent in their duties.

The requirements of the by-law for the disposal of garbage, etc., as passed on the 8th day of July, A.D. 1916, by the Township of Widdifield provide for wooden boxes underneath the closet seat, in a certain prescribed area, but do not provide how these are to be cleaned nor is any provision made for the disposal of the contents of them. My experience is that the iron bucket system is the only efficient method of handling this matter either for winter or summer.

In summing up the sanitary situation in and around the water supply, I have found conditions grievously neglected along the west end of the lake, where everything is wide open for a possible serious pollution of the water supply.

I would advise that the Town of North Bay apply at the next sitting of the Legislature for sanitary control of their water supply, so as to be able to handle conditions with their own machinery.

I will lay this report before the Provincial Board of Health and ask their advice on what further action I may take in assisting to remedy this matter.

DEPOT HARBOUR.

December 11th, 1916.

Complaints having been made that very unsanitary conditions existed at Depot Harbour, I visited that point. Depot Harbour is a portion of the Indian Reserve and is leased for a long term of years to the Grand Trunk Railway. Hotels, schools, boarding houses, and all other buildings belong to the Railway Company.

In the part called Dago Town, consisting of between fifty and seventy-five hovels, I found wells at their very doors, no closets, the inhabitants using the rocks for that purpose.

In the centre of the town there is a septic tank in a fenced-in lot of about one acre, with the contents flowing over the adjacent ground in all directions. Apart from being very dangerous through flies in the summer time, the odor in summer must be very offensive.

I advised L. J. Coleman, Divisional Superintendent of the Grand Trunk Railway at Ottawa, that immediate steps must be taken to have these matters remedied, also to have a garbage system established for the village, making it compulsory for the residents to remove the old cans, garbage, etc., which I saw lying around in quantity.

All of which is respectfully submitted.

George E. Young,

Provincial Sanitary Inspector.

Report of the Provincial Sanitary Engineer

F. A. DALLYN, B.A.Sc. C.E., (Tor.)

Toronto, July 23rd, 1917.

Chairman and Members of the Provincial Board of Health, Ontario.

Gentlemen,—I have pleasure in presenting herewith my annual report for the year 1916, including several reports of Mr. DeLaporte made under your direction in connection with the work of this Department.

Applications approved by the Board relating to sewerage and waterworks systems and extensions thereto, amounted in the year 1916 to the sum of $2,010,-070.42 (estimated costs) and is summarized as follows:

Sewer Extensions	123	applications—estimated	cost	$1,226,260 90
Sewage Disposal Works	7	"	"	97,872 00
Waterworks Extensions	56	"	"	369,035 42
New Water Supplies	4	"	"	316,902 10
Total Applications	190	"	Total estimated cost	$2,010,070 42

The work entailed by consideration of these applications was somewhat less than in 1915 owing to the marked decrease in expenditures, that of 1915 being $4,679,496.94 as against $2,010,070.42 for 1916. The total number of applications, however, does not show so great a difference rising out of the fact that the smaller works and works of necessity have been carried on even with the difficult labour conditions now confronting municipalities in Ontario.

An effort has been made this year to prepare standards for Municipal Records, Proposal for Bids and Estimates, Bid and Estimate, Bond, Contract and Specifications for Sewer Construction together with certain standard details of construction. A tentative proposal is included elsewhere in this report. Standard methods and specifications are suggested in order that the work of the various municipalities may be correlated and to permit of a scheme of Provincial supervision going into operation which is rendered doubly difficult when the contractor's liability is subject to change by reason of the specifications being different for each municipality. With uniform methods it should be possible for a Government Inspector to deal directly with the interpretation of the specifications and with the contractor. Under existing conditions the matter has to be referred back to an engineer whose responsibility frequently terminated with the acceptance of the plans and letting of contracts.

The question of regulations governing the installation of plumbing and sanitary conveniences in the Province of Ontario has been considered and a tentative proposal has been prepared. A standard specification for soil pipe is suggested regulating the sizes, dimensions and weights of soil pipe. This latter is much needed, for competition amongst the manufacturers of drainage fittings has lead to all sorts of artifices in the shortening and lightening of fittings in the endeavour to make, what appears to the ordinary purchaser, a cut in price. Competition can be taken care of either in price lists or on discount sheets. Standard sizes and weights of fittings will be most advantageous for the trade. Standards of the Province of Ontario will doubtless control fittings in the Eastern portion of the Dominion.

A report has been completed with the assistance of Mr. Duff upon the manufacture of sewer tile pipe in the Province. This report is of general interest to city engineers and inspectors in charge of sewer construction throughout the Province. I would recommend that this report be included in the published report of the Board and that it be printed separately for distribution to those interested.

The situation with reference to water borne typhoid fever in the larger towns is very satisfactory. The accompanying table shows a gradual elimination of typhoid for the past few years. *Supervision on the part of the Board without the support*

Laying a 33″ dia. sewer in quicksand, Peterboro', Ont.

of the municipalities in continuing the dosage of chlorine required, is unsatisfactory and largely explains why further decreases have not been realized in some instances. Chlorination is not always sufficient treatment and further purification is desirable notably at Belleville, Kingston, Sault Ste. Marie and Windsor. *With municipal support it is possible to eliminate typhoid as a serious factor in our vital statistics.* The death rate in the Province of Ontario from typhoid fever exclusive of the cities and towns was 8.0 per 100,000 of population in 1916.

TABLE No. 1.

TYPHOID FEVER IN ONTARIO CITIES.

Rate per 100,000 population.

The following rates do not appear to be greatly influenced by water supply.

Cities.	1908	1909	1910	1911	1912	1913	1914	1915	1916	City Average 1908–16	Treatment, Source of Supply.
Brantford	53	24	72	77	17	24	11	11	24	34.7	Chlorination, 1914.
Fort William	....	....	....	35	33	30	21	22	9	25.0	None, Loch Lomond.
Galt	43	11	42	31	19	27	17	0	25	23.8	None, Springs.
Guelph	21	69	27	13	6	6	12	12	0	18.4	Chl. 1915, Springs.
Hamilton	19	16	15	24	8	14	7	6	4	12.5	None, Lake Ontario.
Kitchener	15	15	43	7	19	6	11	5	0	13.4	None, Wells.
London	12	6	4	17	10	3	9	0	2	7.0	None, Springs & Wells.
Niagara Falls	....	....	....	....	...	....	....	9	27	18.0	Chl. 1913, Niagara R.
Ottawa	31	24	28	....	....	19	17	24	18	23.0	Chl. 1912, Ottawa R.
Peterborough	18	6	29	17	10	10	25	14	14	15.9	Chl. 1916, Otonabee R.
Port Arthur	....	....	....	....	....	....	....	5	21	13.0	Chl.1913, New source, '14
St. Catharines	....	24	24	71	22	27	6	0	22	21.7	Chl. 1914, Welland Canal
St. Thomas	49	34	20	19	19	50	0	29	29	27.6	Chl. 1913, Filters, Wells
Stratford	14	34	34	13	20	6	6	17	12	17.3	None, Wells.
Toronto	21	25	46	24	14	13	9	2	7	17.8	Chl.1909, Filters 1912-16
Woodstock	32	21	21	42	30	10	0	10	28	20.6	None, Springs.
Average by years	25.2	23.7	31.1	30.0	17.4	17.5	10.0	9.8	13.4	19.8	

NOTE.—A total city population of 924,610 is benefited by the rates of 10, 9.8, 13.4, for the years 1914, 1915, 1916 respectively.

TABLE No. 2.

TYPHOID FEVER IN ONTARIO CITIES.

Rate per 100,000 population.

The following rates appear to be influenced by infected water supplies.

Cities.	1908	1909	1910	1911	1912	1913	1914	1915	1916	City Average 1908-16	Treatment of Water Supply.
Belleville	71	40	50	19	37	18	17	63	81	44.0	Chlorination 1916
Chatham	49	68	39	38	44	58	16	8	46	40.6	Filters 1895
Fort William	111	106	83			Protected.				10.0	New Source 1910
Kingston	31	31	78	26	32	25	43	28	5	33.2	Chlorination 1912
Niagara Falls	84	26	60	90	44	85	34	protected		60.4	Chlorination 1913
Ottawa	....	....	....	101	108		Protected.			104.5	Chlorination 1912
Port Arthur	138	164	178	121	163	146	50	protected		137.1	New Supply and Chlorination 1913
Sarnia	110	82	101	148	139	45	26	34	60	82.7	Chlorination 1913
Sault Ste. Marie	68	90	154	280	85	127	84	24	31	116.6	Chlorination 1913
Windsor	63	56	49	34	38	10	27	35	29	37.8	Chlorination 1913
Average by years	80.5	73.6	88.0	102.1	76.6	64.7	37.1	32.0	42.0	66.2	

NOTE.—A total city population of 95,017—approximately 8 per cent. of urban population—is effected by the average rate of 42 deaths per 100,000 of population in 1916.

The rapid development of certain industries and particularly the manufacture of explosives throughout the Province has caused unsanitary and congested living conditions in isolated sections and it would be well to enlarge the regulations governing housing accommodation in boarding camps. War contracts during the past two years have been used as an excuse for all sorts of haphazard planning, congested housing conditions and wholesale discharge of trade wastes into some of the waters of the Province. These conditions in themselves might have been tolerated had proper provision been made for sanitary inspection by municipal authorities benefiting by the congestion or by the munition contracts. As it was, work of this kind had to be undertaken directly by officers of the Board and it was only after outbreaks of fever had occurred, such as at Parry Sound, that any proper appreciation was had of regulating the conditions under which congestion could be permitted.

Straightening the steel sheeting, Peterboro', Ont.

The work of the Department has required visits to the following places during the course of the year:

January.—Sarnia, Davenport, Iowa, Chicago, Ill., Milwaukee, Wis., and Guelph.

February.—Stratford, Sarnia and Peterborough.

March and April.—Sarnia, Washington, D.C., Baltimore, Md., Niagara-on-the-Lake, Sarnia, Milwaukee, Wis., Renfrew, Orillia and Guelph.

May.—Rockland, Ottawa, Pembroke, Sault Ste. Marie, London and Owen Sound.

June.—London, Pembroke, Renfrew, Ottawa, Winchester, Niagara Falls, Buffalo, Niagara Falls, Thorold, Detroit and Orillia.

July and August.—Baltimore, Md., Guelph, Lindsay, Sudbury, Coniston, Ogdensburg, Smith's Falls, and Ingersoll.

August and September.—Oakville, Burlington, Peterborough, Sault Ste. Marie, Camp Borden, Collingwood, Georgetown, Petewawa, Quebec, and Strathroy.

October and November.—Berlin-Kitchener, Parry Sound, Guelph, Ottawa, Kingston, Oshawa and Napanee.

December.—Westboro.

Such reports as appear of general interest arising out of these visits are included herewith.

I have the honour to be,

Yours sincerely,

F. A. Dallyn,
Provincial Sanitary Engineer.

Sewer Extensions for the Year 1916.

Municipality.	Date.	Estimated cost.
Arnprior	Nov. 29th	....
Barrie	Nov. 10th	$550 00
Belleville	Aug. 28th	16,617 71
Berlin	Aug. 31st	9,300 00
"	Aug. 31st	7,176,00
Brampton	July 20th	20,030 94
Brockville	Nov. 18th	2,608 00
" (Sewer and Pump Station)	Nov. 29th	5,178 71
Chatham	Nov. 20th	16,127 96
Collingwood	April 12th	7,000 00
Copper Cliff (Sewer and Dis. Works)	July 3rd	28,212 33
Cornwall	Nov. 29th	2,500 00
Dunnville	May 16th	342 00
"	Aug. 10th	3,502 94
Fort William	Aug. 28th	888 20
Galt	Aug. 28th	1,135 80
Gananoque	Aug. 15th	4,000 00
Guelph	July 2nd	4,500 00
"	Nov. 2nd	805 00
Hamilton	Mar. 16th	345 97
"	June 28th	356 00
"	July 26th	1,060 47
"	Aug. 9th	....
"	Sept. 19th	1,101 25
"	Oct. 3rd	577 00
"	Oct. 23rd	12,944 80
"	Dec. 20th	734 10
Kingston	April 26th	238 75
"	May 18th	173 00
"	Sept. 18th	305 45
"	Oct. 31st	1,087 95
Leamington	April 10th	20,537 72
Lindsay	Sept. 18th	7,808 15
London	Mar. 21st	4,199 22
"	April 7th	10,133 67
"	July 3rd	3,268 30
"	July 3rd	1,593 21
"	July 3rd	1,327 10
"	July 3rd	1,799 90
"	July 3rd	1,004 57
"	Oct. 3rd	929 30
"	Oct. 3rd	327 00
"	Oct. 3rd	3,635 95
"	Oct. 3rd	3,590 40
"	Oct. 20th	5,072 55
"	Nov. 14th	3,012 77

SEWER EXTENSIONS FOR THE YEAR 1916.—*Continued.*

Municipality.	Date.	Estimated cost.
Lorneville (Tp. Cornwall)	Aug. 18th	882 60
Mimico	Dec. 1st	14,069 21
New Toronto	May 13th	51,235 36
"	June 16th	364 00
"	June 19th	5,375 00
"	Dec. 14th	3,325 48
Niagara-on-the-Lake	Aug. 28th	4,064 17
"	Aug. 31st	7,489 36
North Bay	June 16th	3,744 50
"	Aug. 8th	1,249 00
"	Nov. 9th	326 60
"	Dec. 7th	2,050 00
Oshawa	Aug. 8th	2,703 00
Ottawa	Jan. 20th	1,460 85
"	Jan. 20th	3,238 40
"	Feb. 24th	2,848 90
"	Mar. 13th	971 86
"	Mar. 13th	266 05
"	June 24th	853 42
"	July 6th	486 68
"	Aug. 18th	3,713 99
"	Aug. 28th	925 06
"	Nov. 14th	1,039 00
Parry Sound	June 24th	5,570 00
Pembroke	July 20th	179 18
Perth	Jan. 15th	3,341 23
"	May 26th	595 65
"	Aug. 9th	1,167 25
Peterborough	Nov. 29th	4,219 37
Port Hope	May 1st	1,845 98
"	May 1st	458 50
"	June 2nd	1,945 41
Renfrew	Sept. 26th	2,000 00
St. Catharines	Feb. 4th	4,481 00
"	Feb. 12th	24,770 24
"	June 24th	79,583 71
St. Thomas	Mar. 13th	2,489 02
"	Dec. 4th	75,565 54
Sandwich	June 16th	2,614 08
"	June 16th	722 70
"	June 16th	743 60
"	June 20th	2,258 74
"	June 20th	4,516 15
"	June 24th	4,307 05
"	July 12th	344 24
"	July 20th	1,227 60
"	Nov. 24th	18,662 40
"	Nov. 29th	837 80
Sarnia	June 16th	3,107 65
"	July 20th	2,520 85
"	Aug. 28th	2,398 67
"	Nov. 14th	2,685 20
Sault Ste. Marie	Nov. 21st	2,253 36
Smith's Falls	July 3rd	9,305 00
"	Oct. 16th	231 29
"	Nov. 17th	16,441 25
"	Dec. 18th	1,533 75
Stratford	Aug. 1st	1,539 50
"	Aug. 1st	1,265 35
"	Nov. 7th	617 00
Sudbury	Aug. 14th	7,500 00
"	Nov. 14th	275 00
"	Nov. 14th	700 00
Thorold	Feb. 8th	364 05
"	June 8th	2,417 00

SEWER EXTENSIONS FOR THE YEAR 1916.—*Continued.*

Municipality.	Date.	Cost.
Toronto	Jan. 4th	50,706 00
"	June 16th	14,852 00
"	June 19th	279,070 00
"	July 20th	2,668 00
"	Oct. 18th	227,592 52
"	Oct. 24th	....
Waterloo	Sept. 18th	3,423 00
Welland	May 6th	3,199 14
Whitby	Nov. 27th	6,945 27
Windsor	May 19th	3,636 85
"	June 29th	1,505 68
"	Nov. 11th	2,738 45
	Total cost of extensions	$1,226,260 90

SEWAGE DISPOSAL WORKS.

Brockville (Sewer and Pumping Station)	Nov. 18th	$1,872 00
Copper Cliff (Sewer and Disposal Works)	July 3rd	19,500 00
London	April 18th	50,000 00
New Toronto (Sewer and Pumping Sta.)	June 19th	25,500 00
Tecumseh—(Dominion Canners)	Feb. 8th	....
Toronto (Women's Industrial Farm)	June 26th	....
Weston	April 7th	1,000 00
		$97,872 00

WATERWORKS EXTENSIONS FOR THE YEAR 1916.

Berlin	April 25th	$14,795 78
" duplicates	May 30th	....
Chatham	Aug. 28th	16,600 00
Cochrane	Aug. 8th	788 52
Cornwall	April 13th	25,000 00
Essex	Jan. 17th	5,800 00
Ford City	July 12th	8,625 39
Galt	Sept. 8th	2,349 49
Gananoque	Aug. 15th	4,000 00
Grantham Township	Aug. 8th	9,290 00
Hamilton	Mar. 30th	3,291 52
"	June 29th	2,021 72
"	Aug. 14th	350 00
"	Oct. 17th	2,562 38
Kingsville	Oct. 6th	5,250 00
Midland	July 5th	2,288 00
"	Aug. 28th	237 00
"	Sept. 18th	858 00
Mimico	Dec. 1st	22,586 11
Niagara-on-the-Lake	April 27th	....
Peterborough	Mar. 13th	7,370 31
"	April 5th	35,364 00
"	Sept 8th	11,330 50
Preston	May 19th	325 70
"	Aug. 28th	1,876 40
Renfrew	Sept. 26th	3,974 90
Ridgetown	Sept. 18th	6,028 25
St. Catharines	June 1st	5,000 00
Sandwich	May 12th	2,047 72
"	June 20th	5,967 50
"	June 24th	3,520 00
"	July 10th	748 00
"	Aug. 21st	1,441 00
"	Nov. 24th	16,771 60
"	Dec. 1st	616 00
Seaforth	Oct. 26th	4,248 00

WATERWORKS EXTENSIONS FOR THE YEAR 1916.—*Continued.*

Municipality.	Date.	Cost.
Smith's Falls	April 12th	1,600 00
"	Oct. 16th	315 40
"	Nov. 17th	3,964 00
"	Dec. 18th	276 75
Stamford Twp.	May 6th	6,382 00
"	Dec. 21st	465 00
Sudbury	Jan. 17th	10,813 00
"	Jan. 24th	1,096 00
"	Nov. 14th	550 00
Timmins	July 19th	22,001 00
Toronto	Jan. 4th	6,527 17
"	Jan. 15th	3,726 44
"	Aug. 21st	2,790 26
"	Sept. 19th	2,056 27
"	Oct. 31st	6,591 64
"	Nov. 6th	3,367 47
"	Dec. 7th	1,942 14
Whitby	Nov. 27th	5,594 23
Windsor	June 24th	55,652 06
Total cost waterworks extensions		$369,035 42

NEW WATERWORKS AND PURIFICATION.

Collingwood	Mar. 17th	$13,000 00
Niagara-on-the-Lake	May 15th	11,822 84
Peterborough (chlorination apparatus)	April 14th	....
Tp. of York	Oct. 14th	265,062 23
"	Nov. 14th	27,017 03
		$316,902 10

TORONTO, Nov. 28th, 1916.

Dr. J. W. S. McCullough, Chief Officer of Health, Ontario,Toronto, Ont.

RE OSHAWA WATER SUPPLY.

SIR,—I have the honour to report in respect to the marginally noted subject as follows:

The water supply of Oshawa has for some time been showing considerable pollution as indicated by the analysis made at the Laboratory of the Board since the middle of 1915. It was thought advisable that a survey should be made of this water supply and on April 19th, 1916, Mr. DeLaporte visited the town and made a report. This report led to the recommendation that chlorination apparatus be immediately installed which was done by the town Engineer and is now in use. Recent reports of Dr. Clinton, District Officer of Health, indicate that considerable trouble has lately been experienced owing to anthrax breaking out in cattle which make frequent use of the stream receiving the tannery effluent, and of pasture lands which have received the droppings of animals possibly at some time infected by the tannery waste. The condition appeared to be one warranting a visit to the town and a more thorough examination into conditions respecting both the disposal of wastes and the purification of the water supply.

PROTECTION OF THE WATER SUPPLY.

On November 20th I visited Oshawa and went over the premises of the principal offenders in regard to the pollution of the creek, that is, The Robson Leather Company, The Scoffield Woollen Company and the Oshawa Cannery, and at the

same time visited the sewage disposal works, the pumping station and the water front. To sum up the whole situation in a few words the water supply unquestionably requires further protection, for the reason that it receives periodic pollution from the sewage of the town (which is discharged after sedimentation without disinfection), some considerable pollution from the tannery wastes and wash water from the woollen mills.

I can suggest no better immediate treatment of the water supply than by use of mechanical filters, and I would recommend that proposals be asked both for pressure and gravity types of mechanical filters, and include a proposal for the drifting sand type now in operation at Toronto Island Filtration Works. The chemical used could, I believe, be fed most advantageously by the new equipment now being put on the market by the VerMehr Company, of Toronto, which is a pressure apparatus, solution being controlled by a hydrometer. I would advise the continuance of the use of bleaching powder even after filtration, but I anticipate very much smaller quantities can be used than at present. There will probably be no taste whatever owing to the use of alum with the filter. The chlorine may be fed before or after filtration.

Sewage Purification.

The present devices, that is the detritus chamber and sedimentation tank, appear to be doing a satisfactory work, but both require cleaning. The practise, I believe, has been to discharge this accumulated filth directly into the creek and allow it to find its way with freshets to the water front and possibly to the intake. This is improper and should in future be corrected by the construction of a suitable sludge bed which can be underdrained in the ordinary manner, and after drying, the sludge may be distributed around the sewage disposal area fertilizing the rather fine growth of trees there.

The effluent from the sedimentation tanks should be chlorinated at once and this practise should be continued. It is advisable to provide for the further treatment of the sewage by spraying it over broken stone as is practised in many centres. This will improve the color very markedly and will abate the odour which is complained of at the water front. This odour is due to putrefaction of weeds occasioned by the loss of oxygen in the stream, the oxygen being absorbed by the sewage as it is now discharged.

The Tannery.

The Robson Leather Company are quite serious offenders against the Public Health Act, for the reason that they are discharging untreated wastes and polluting the stream seriously to the detriment of the town and of any agricultural interests below. It was not possible in the limited time at my disposal to determine the exact quantity of water being used at the tannery. We are informed, however, that approximately 1,200 hides were being treated per day, which is equivalent to the discharge of three soak pits or fresh water vats 8 x 8 x 6 feet and three lime vats 8 x 8 x 6 feet, together with large volumes of wash water, some dye waste, chrome and periodically some spent liquors from the other tanning processes. The total quantity of water used cannot possibly be less than 51,000 gallons per day. Judging by other tanneries I would estimate it as more nearly 200,000 gallons per day.

For the protection of the stream, and I believe for the direct advantage of the Robson Leather Company in regard to their responsibility as to anthrax, the fol-

lowing waste water disposal works should be immediately installed: (1) Two sedimentation tanks to be constructed in parallel for cleaning purposes, each 15 feet deep with cone bottom and 10 x 10 feet in area, these tanks to receive nothing but the wastes from the fresh water or soak pits and the lime vats, together with the fresh water associated directly with this portion of the process. I understand that there is sufficient lime discharged to satisfactorily sterilize the water of the soak pits if the two are mixed and allowed to stand together for some 18 to 20 hours, which would be made possible by the arrangement proposed. The rest of the wastes except those from the dye vats, together with the overflow from the first two tanks should then be discharged through two other tanks 7 feet deep, 10 feet wide and 25 feet long, the tanks to be both operated normally or one set while the other was being cleaned. It is immaterial whether shallow tanks be constructed or not, provided that the storage indicated can be completely taken advantage of.

The most satisfactory method of taking care of the dye and colored liquids would be to have a small storage tank, one probably holding 1,000 or 1,500 gallons and arranged to flow into the first tanks, that is, the tanks receiving the soak pits and lime vats, the flow from the dye waste tank to be continuous from a small orifice so that the heavy rushes of dye liquor will not go directly to the stream, but will be distributed throughout the twelve hours or so of the working day with the other liquors.

I believe this is all that can be reasonably asked of the Leather Company. This can be constructed for less than $6,000.00. The treatment recommended will yield an effluent which should not give rise at any time to anthrax in the lower waters provided that the tanks are kept reasonably clean and that the lime vats are discharged so as to effect the water from the soak pits.

The Schoffield Woollen Company.

Considerable wool washing is done at this plant and no provision has been made for treating the wash water. I would suggest a concrete tank 6 feet wide and a depth sufficient to have 4 feet of liquor and 20 feet long, the flow to be arranged longitudinally and the tanks to be divided into two sets so as to permit of cleaning one set.

The wastes from the toilets at the Schoffield Woollen Mills should be discharged through tile into ground which can be conveniently made in that neighbourhood by filling in with ashes and other waste material. Under present condition the discharge is by siphon direct to the creek and occasions offence in somewhat the same way as the town sewerage, by depriving a portion of the creek of its oxygen so as to occasion an offensive decay of the weed growth.

The Oshawa Canning Company.

These people appear to be probably the least offenders in respect to the pollution of the stream and doubtless will in the near future be connected to the sewerage system. I would recommend, however, that their waste water be passed through a tank about 10 x 10 x 7 feet so that in case of accident or doing a rush of work, some of the wastes having least value will not be discharged directly into the stream in order to get rid of them. The tank should be so built that when the sewer is laid it will be connected to the overflow of the tank rather than to the drains of the Canning Company.

In concluding my report I should like to repeat an observation made to Mr. Worden, the Engineer, with reference to the existing chlorine apparatus. *The apparatus should be so arranged that the pump operator can start his chlorine solution flowing before starting the pump.* Under the existing methods the pumps are started four times a day and are operated for a period of probably two minutes on each occasion before the chlorine solution is turned on. That means that each day probably as much as 8,000 gallons of water are pumped into the system which have absolutely no treatment whatsoever, and should conditions be such on that day that the sewage is reaching the intake pipe, the water would be highly dangerous. This is a common error made by those in charge of apparatus for chlorination and has in some places led to serious outbreaks of typhoid fever.

All of which is respectfully submitted.

F. A. Dallyn,
Provincial Sanitary Engineer.

Toronto, April 19th, 1916.

Dr. J. W. S. McCullough, Chief Officer of Health, Ontario, Parliament Buildings.

Report re Oshawa Water Supply.

Sir,—Acting under your instructions, I made a sanitary survey of the water supply for Oshawa on April 19th in company with Mr. Worden, Town Engineer.

I went over the location of the intake pipe in regard to possible sources of pollution. It has long been a well-known fact that the water from the creek, which passes through the town, occasionally finds its way into the water supply. This has been amply demonstrated this spring when there could be no doubt both from the character of the water and of the suspended solids that the creek water was polluting the supply. As all the sewage from the Town of Oshawa is emptied directly or indirectly into this stream, it is easily seen that while the water supply may not be polluted at all times, it is nevertheless highly charged with sewage part of the time.

Efforts have been made this spring to have the people chlorinate the water in their homes, Mr. Worden having a recipe similar to that of the Provincial Board of Health published in the local papers. This home chlorination is a very unsatisfactory method at best, and I recommend that the town instal immediately a temporary chlorination plant to ensure the safety of the supply while further measures of protection are being devised.

All of the above is respectfully submitted.

A. V. DeLaporte,
Chemist in charge of the Experimental Station.

RE PARRY SOUND.

TORONTO, February , 1916.

Provincial Board of Health, Ontario, Toronto, Ont.

GENTLEMEN,—Acting on instructions from the Chief Officer of Health I visited Parry Sound February 21st, 1916, to see that the chlorination of the town water was being successfully carried out. When I arrived no chlorine was being added to the water as the apparatus was not complete, but the dosing of the water was started on the morning of February 21st. Chlorination is at present being carried on in as efficient a manner as possible with the apparatus at hand. The dose I ordered was 30 pounds of chlorine to every million gallons of water pumped, or roughly one part per million of available chlorine was added.

Chlorination of this supply alone will not stamp out the epidemic of typhoid fever in this town. Other measures are necessary, first, with regard to the overcrowding. The menace of the universal overcrowding in boarding houses and hotels in this town cannot be overestimated. In one boarding house of five small rooms they provide sleeping accommodation for 120 men, 60 men at night and 60 men in the day time. Imagine meningitis, diphtheria or smallpox starting.

This overcrowding is caused by the indifference of the Canadian Explosives Company to the health and welfare of their employees. Two thousand five hundred men were brought to the town with a normal population of 3,000 people, roughly doubling the population in three months, and to date no extra provision has been made for the accommodation of these men, with the consequences that the housing conditions beggar description. Immediate steps should be taken to make this Company realize its duty to its employees. Secondly, no sanitary by-laws are enforced in this town. Steps should be taken (*a*) to pass and enforce an adequate sanitary by-law, and (*b*) to collect the garbage and the night soil from the numerous privies about the town. If these steps are not taken promptly the chlorination of the water will be to some extent futile and the duration of the epidemic will be protracted indefinitely.

Enforcement of the sanitary by-law should be placed in strong hands, who will require vigorous action to stamp out the present epidemic and to prevent an outbreak of some other disease.

I would, therefore, respectfully suggest that the Provincial Board of Health of Ontario take this matter in their own hands and clean this town as it ought to be cleaned.

All of which is respectfully submitted.

A. V. DELAPORTE,

Chemist in charge of the Experimental Station.

Report Upon London Sewerage and Sewage Disposal and in Regard to Certain Nuisances.

From the Provincial Sanitary Engineer to the Chief Officer of Health for Ontario.

Sir,—I beg to report upon the conditions affecting the extensions of the present sewerage system of the City of London and more especially in reference to the present campaign of Dr. Hill for the abolishing of all outside toilets and the enforcement of the by-law requiring connection to be had to the existing sewerage system.

At the present time the 20-inch syphon connecting the main sanitary sewer to the disposal works is entirely inadequate and no doubt was so for a considerable period prior to 1913. There is a note of the matter in Mr. Chipman's report to the council, under date of April 19th, 1913, in which is the statement that "the 20-inch syphon is now capable of taking only 30 per cent. of the capacity of the sewer and that an additional 30-inch was needed at once." This condition has been brought about by the city's rapid growth and an almost universal custom of connecting roof water to the sanitary system. No action was taken in the matter by the council although the expense of laying such a syphon under the present conditions would probably not be more than $40,000.

The serious flooding which began to be evidenced in parts of the city was deemed of more importance, and at this time the council, ignoring the recommendation with reference to the syphons, proceeded with the construction of storm sewers, the cost of which was estimated at that time to be in the neighborhood of $171,000. Mr. Chipman undoubtedly believed a great deal of relief could be afforded the existing system by the system of storm sewers, and, I have no doubt, made provision for overflows from the existing system entering them. This work was not authorized by the Provincial Board of Health who were not consulted on any manner at this time. The debenture issued was validated by a bill of the legislature—Chapter 58 of the Statutes of Ontario, 1915, 5 George V.

Application was made to Mr. Ashplant, the city engineer, under date of April 2nd, 1914, for copies of the surveys in connection with this matter, but although the letter was acknowledged on April 3rd, nothing was done in the matter and to this date no plans have been furnished to the Board.

There appears to be no good reason why a portion of this money could not have been devoted to the purpose of constructing an additional syphon instead of spending as much as $216,000 on the storm sewer system, which is the expenditure to date.

Under date of July 14th, 1915, Dr. Hill wrote inquiring as to the Board's attitude in respect to the use of septic tanks draining directly to the river in some of the areas inaccessible by gravity to the city sewerage system, which letter was answered July 20th. At a later date, February 9th, 1916, Dr. Hill again wrote, mentioning the fact that there were some 2,800 outside toilets in London, of which approximately 90 per cent. could be connected with the existing sewers, the other portion being in areas difficult to remedy.

In response to this letter and, upon request of Dr. Hill for investigation of certain nuisances by reason of which raw sewage was emptying into the river above and in the middle of the city, a visit was made on May 17th to the City of London to examine into the matter. All of the nuisances examined, a list of which is attached hereto, while doubtless being infringements on the clause respecting pollution of streams, appeared of minor importance when compared with the glaring neglect of the city authorities in respect to their own sewage, 70 per cent.

of which (according to Mr. Chipman's report and further confirmed by our own observation) enters the river raw and untreated within the limits of the municipality, no attempt being made to carry the sewage to the disposal works.

In reference to the matter of abolishing outside privies and connecting the existing sewers, the city should need no instruction from this Board, as sub-section 2 of Section 25 of the Public Health Act adequately covers the matter. A by-law should be passed condemning the existence of outdoor privies where premises could connect to sewers, and reciting the same as nuisances, in order to proceed legally under the Act. For your information I may say that I learned with considerable astonishment that although there were in existence at least 2,800 outside toilets, with the possibility of there being 4,000, no effort had as yet been made to enforce screening or to systematize the removal of night soil, the matter being left entirely to the householder. A yearly inspection by a force selected at random once a year for that purpose is made during the months of May or June. It is presumed that such a force would not have any proper instruction as to what to condemn in the way of inadequate or improperly constructed conveniences. There appears to be no good reason why this matter could not be carefully supervised either under the Street Cleaning Department or under the Local Board of Health, in view of the somewhat under-staffing of the municipal officers.

In summing up the situation, I am of the opinion that the municipality has been grossly negligent in regard to their own sewage disposal, that the storm system has proved inadequate to prevent flooding of the 20-inch syphon, that the city is by-passing large portions of their sanitary sewage, and that the abolishing of outdoor toilets should be proceeded with at once and be under the supervision of a plumbing inspector having powers under a proper by-law with reference to the installation of sanitary conveniences to replace the ones abolished, and that the use of outdoor flush toilets connected with sewers be abolished on account of their extreme wastefulness in reference to water consumption.

The matter of making the proper surveys to determine the existence and location of privy vaults is rightly one within the jurisdiction of the Local Medical Officer of Health, and should be undertaken by his department. The preparation of a report upon the affording of sewage facilities to low-lying districts comes properly within the province of the city engineer's department, and should be authorized by council upon proper recommendation of the Medical Officer of Health.

A continuance of the present method of discharging from 3,000,000 to 5,000,000 gallons daily in the Thames River some sixty miles above Chatham is not to be recommended. It appears advisable that London should at least make an effort to convey its sewage to the sewage disposal area and proceed with studies to determine the most economical method of removing the solids and to partially disinfect the sewage.

All of which is respectfully submitted.

F. A. Dallyn,

Provincial Sanitary Engineer.

May 25th, 1916.

London, May 10th, 1916.

To the Medical Officer of Health, City.

Dear Sir,—The following are sewer outlets into the river:
Spettigue Rendering Works.
McClary's, south-east foundry. Across the river. Chelsea Green.
Wellington Street, south side.
Wellington Street, north side.
South Street, at river.
Richmond Street, south end.
Hydro into mill race.
Ridout Street, south side.
Horton Street, rear gas house.
York Street, bridge, both sides of river.
King Street, bridge, overflow they say.
Dundas Street, under water.
Blackfriars, bridge, overflow.
Carling's Creek, Hyman's Tannery.
Carling's Brewery into river.

Respectfully,

Sgd. James Lutman,

Sanitary Inspector.

Re Lindsay Water Supply.

Toronto, October 24th, 1916.

Dr. J. W. S. McCullough, Chief Officer of Health, Ontario, Toronto.

Sir,—I have the honour to report that on July 24th I visited the Town of Lindsay at the request of Dr. McAlpine, Medical Officer of Health, for the purpose of advising him upon certain drainage problems in the neighbourhood of the Dominion Arsenal. While at Lindsay I had the opportunity of examining the town's water purification plant.

The water consumption of the town is now such that approximately 650,000 gallons are pumped during the day as the yearly average, and it is expected that the Dominion Arsenal will create a further demand of at least 200,000 gallons per day. The ozone apparatus as designed by Mr. Bridge, according to Dr. Naismith's report, was intended to treat about 500,000 gallons as a maximum.

The present filters which have been constructed from time to time by the town are of local design and are operated without the use of alum. I regret to report that the whole plant requires rather extensive remodelling. The operation of the ozonizing apparatus does not appear to have been materially changed since Dr. Naismith made his report. The pump attendant further informed me that *owing to defects in the ozonizers they are operated intermittently,* whereas, the water consumption necessitates the pumps being operated continuously.

Furthermore, analyses made from time to time over the past two years show the water (not only at the source of supply, but frequently also at taps located in

various parts of the town) to be seriously contaminated, and it may be accepted as a fact that no matter what ozonization may do for water in theory, the efficiency of the apparatus at Lindsay in removal of bacterial organisms, appears to be almost nil.

Considerable trouble also arises when back-washing the filters. This is due to the fact that the variations in the level of the Scugog River necessitate the wash water troughs being kept six to seven feet above the filter media, which makes it almost impossible to remove the mud in suspension. Good filter design places the height of the wash water troughs from 18 to 22 inches above the sand.

The Fire Underwriters are asking for further pumping units to be installed and I am informed that the Hydro-Electric Commission have been requested to make some suggestions along that line. The existing pumping station is very much crowded and any additional units will, in all probability, be separately housed.

The revenue of the town waterworks over and above all operating expenses and repayment of the existing debentures was shown to be $7,229.28 in 1914. It appears from this that an expenditure on capital account for improvements to plant amounting to as much as $100,000 could be made without altering the existing water rates. It is a question of doubtful policy to permit water companies to serve as revenue producers for the municipality at large at the expense both of public health and adequate fire protection.

From conversation with the town authorities, the Medical Officer of Health and the members of the engineering staff of the Hydro-Electric Commission, it appears that the concensus of opinion is that considerable changes should be made in the immediate future to the pumping station and the purification plant. Naturally the ozone plant is a bone of contention. *There is no question that with the existing arrangements the plant is of practically no use and as far as I can see performs no useful function.*

It is possible that by changing the position of the aspirators the existing plant can be put to considerable service, and incidentally by drawing air continuously through the ozonizers it is possible that they may work without over heating, as is now the case. I believe the most advantageous arrangement would be to put in a set of low lift pumps with a batch of pressure filters to be nominally operated by the low lift pumps, but built of such strength and so cross connected that they can be used in series with the service pumps. The recently constructed gravity mechanical filter could then be used as a sedimentation tank and such portion of the sand in the existing chambers as is of suitable quality could be used for filling the pressure filters. A new building would be required to house the pressure filters and could be so arranged as to provide for filter extensions in one wing and pump house extensions in another, the building being shaped like an "L" with the first battery of filter units placed in the corner.

Excluding cost of the pumps, a suitable building and the filters for the present capacity of one million gallons, capable of being overloaded to give a total yield of one and one-half million gallons, would not cost more than $15,000. Advantage would be taken of the ozone plant. The operation would be in the following manner: The water from the river would flow to the sedimentation basin, receiving as it enters the basin a small dosage of alum. After passing the basin the water enters a pump well and is then forced by the low lift pumps through the pressure filters and thence to a small storage tank controlling the flow through the aspirators. The aspirators in this instance would be of the design used at Baltimore and so placed that the warm air from the ozonizers will have no diffi-

culty in being drawn to the tubes, as is now the case. The water after passing the ozonizers flows down through the ozonizing water and would rise in the existing pump well to a greater height than is now the case. From the pump well the water will be delivered by service pumps to the town under suitable pressure.

The new filter building could be arranged to house new electrical pumping equipment and permit utilization of the existing steam plant as a standby generating station to offset peak load conditions.

Whether or not the proposed changes are carried out I am of the opinion that chlorination should be required for the water supply of the Town of Lindsay until such time as the purification methods can be shown to be adequate by bacteriological tests.

All of which is respectfully submitted.

F. A. Dallyn,
Provincial Sanitary Engineer.

Re Lindsay Water Supply.

Toronto, October 31st, 1916.

Dr. J. W. S. McCullough, Chief Officer of Health, Ontario, Toronto.

Sir,—I beg to report that acting under your instructions, a visit was made at Baltimore, Md., in company with two officials from the Town of Lindsay, Mr. Davidson of the Hydro-Electric Commission and Mr. DeLaporte of the Experimental Station, for the purpose of enquiring into the operation of the ozone plant under the management of the Baltimore County Water and Electric Company.

This Company, at the Herring Run plant, is treating from three to four million gallons of water per twenty-four hours, and their works are of considerable magnitude. The water is taken from the river some distance above the municipality to be served, and is stored in a reservoir having a capacity of approximately eighty-five million gallons. The depth of water in the reservoir varies from 10 feet to 20 feet. The water, as it leaves this reservoir, is treated by the ozone process and is then elevated to an open reservoir, having a twelve million gallon storage capacity. Their chemist, Mr. Sheppard T. Powell, stated that in the raw water colon bacilli were normally present in 1-10 cc., that after storage they were only present in 1cc., and after treatment only in 10 cc.; the bacterial counts being reduced from 6,000 in the raw to 400 after storage and 70 after treatment; (the bacterial counts were made on agar agar 37 degrees incubation).

The ozonizers and the aspirators used in this plant are of local design, having it is understood, been designed by Mr. A. E. Walden and Mr. S. T. Powell, the former of whom has applied for patents. The particular feature of the ozonizers is the use of micanite dielectrics and the convenient manner of replacing them. The aspirators are of cast iron with an enamel finish to protect against corrosion.

Considerable tile pipe is used about the plant for conveying the ozonized air to the aspirators.

It has been found convenient to use low lift pumps to obtain a velocity through the aspirators which is done by elevating the water to a storage tank and arranging the aspirators to work under a two foot head.

The aspirators are arranged in batteries, permitting extra dosing as well as making possible replacing of units either out of service or being repaired.

The ozonized air was said to contain from .6 to 2 grams of ozone per cubic metre, the normal operation being with ozonized air containing two grams per cubic metre. No devices had been placed to determine what volume of ozonized air was being received at the aspirators.

The application of ozone was measured by current consumption and the number of ozonizers in service. It was estimated that about 1/4 of a cubic metre of ozonized air was received at the aspirators for each cubic metre of water.

The engineer reported that $2.00 covered the cost of treating each million gallons with an electrical charge of $3.00 per month per kilowatt of demand. Two hundred and ten kilowatts was apparently being used to run the entire plant treating from three to four million gallons.

The plant consisted of rotary convertors, a low lift pump delivering 4,200 gallons per minute with a total lift of 8 feet (pump and motor 400 R.P.M.) and the ozonizers. The pumpage of water from the storage reservoir to the overhead tank was controlled by an automatic Butterfly valve, the pump was operated for continuous duty.

The large open reservoir gave rise to considerable algal growth, which was removed or treated periodically sometimes as often as twice a week with four to five pounds of copper sulphate, according to the figures of the chemist, Mr. Powell. The copper sulphate was dissolved in the usual manner by placing in a bag and drawing it through the water by means of a row boat.

The water after treatment is not as clear as filtered water although little or no complaint is made of its character.

The cost given for the treatment at Baltimore does not include capital charges on the storage reservoir so that the cost of $2.00 is practically a direct charge. Mechanical filtration of the water at a cost of from three to four and one-half dollars will effect equally good results as far as the removal of organisms is concerned. It will also remove colour and clarify the water, the clarification being a distinct advantage over the ozone process. Mr. Powell's claim that a removal of organisms of over 90 per cent. is effected by the ozonization, I believe, can be substantiated and his further claim that the taste of the water occasioned by algal growth both in the river and in the storage basin, is materially improved by the process, I believe, can also be shown. Ozonization elsewhere should not be called upon to make more than 90 to 95 per cent. removal of organisms with some improvement in the colour and taste of the water. Destruction of organic life by the ozone process is unquestionable, but I do not think this is a serious problem at Lindsay. In view of the fact that the water is now used with little or no objection, I have, therefore, not discussed it.

The use of ozone for the Town of Lindsay appears to be without advantage. From my own observations I should say that the use of alum with mechanical filters of improved type would give them much superior results than can be obtained by the use of prefilters without alum but followed by the ozone treatment. The cost is approximately the same either way. However, if the existing ozone plant at Lindsay is to be continued I would recommend that a type of aspirators such as used at Baltimore, be adopted and that the aspirators be placed so that the suction will be sufficient to draw air from the ozonizers. As will be seen in the report on Lindsay supply the present arrangements do not permit this. I would say that the ozonization at Baltimore has proved a success, but that natural advantages such as the storage of the water have materially helped toward this end.

Through the courtesy of the Engineer, Mr. A. E. Walden, the party was able to see a good deal of Baltimore City and Baltimore County, and to visit another of their water purification plants at which the water was treated by a rapid sand filter plant of modern construction. Too much cannot be said of the courtesy of Mr. Walden and the Chemist, Mr. Powell, who did all in their power to make the visit both entertaining and profitable.

All of which is respectfully submitted.

F. A. Dallyn,
Provincial Sanitary Engineer.

Re Kitchener Water Supply.

Toronto, October 30th, 1916.

Dr. J. W. S. McCullough, Chief Officer of Health, Ontario, Toronto, Ont.

Sir,—I have the honour to report that upon request of the Local Board of Health of the City of Kitchener an examination was made of the source of the water supply, for the purpose of enquiring into some slight pollution shown to exist in the tap water from time to time.

The main portion of the water supply for Kitchener is obtained from a series of artesian wells. The wells, with the exception of one 7-inch, have been driven, using 8-inch casing. The depth varies from 197 to 113 feet, with one deep well 280 feet. Each well is pumped individually by an equipment composed of a small electric motor and centrifugal pump. The water is conveyed to a large storage reservoir (1,500,000 capacity) situated behind the pumping station, from whence it is delivered to the town mains and elevated tank under pressure of from 75 to 80 pounds.

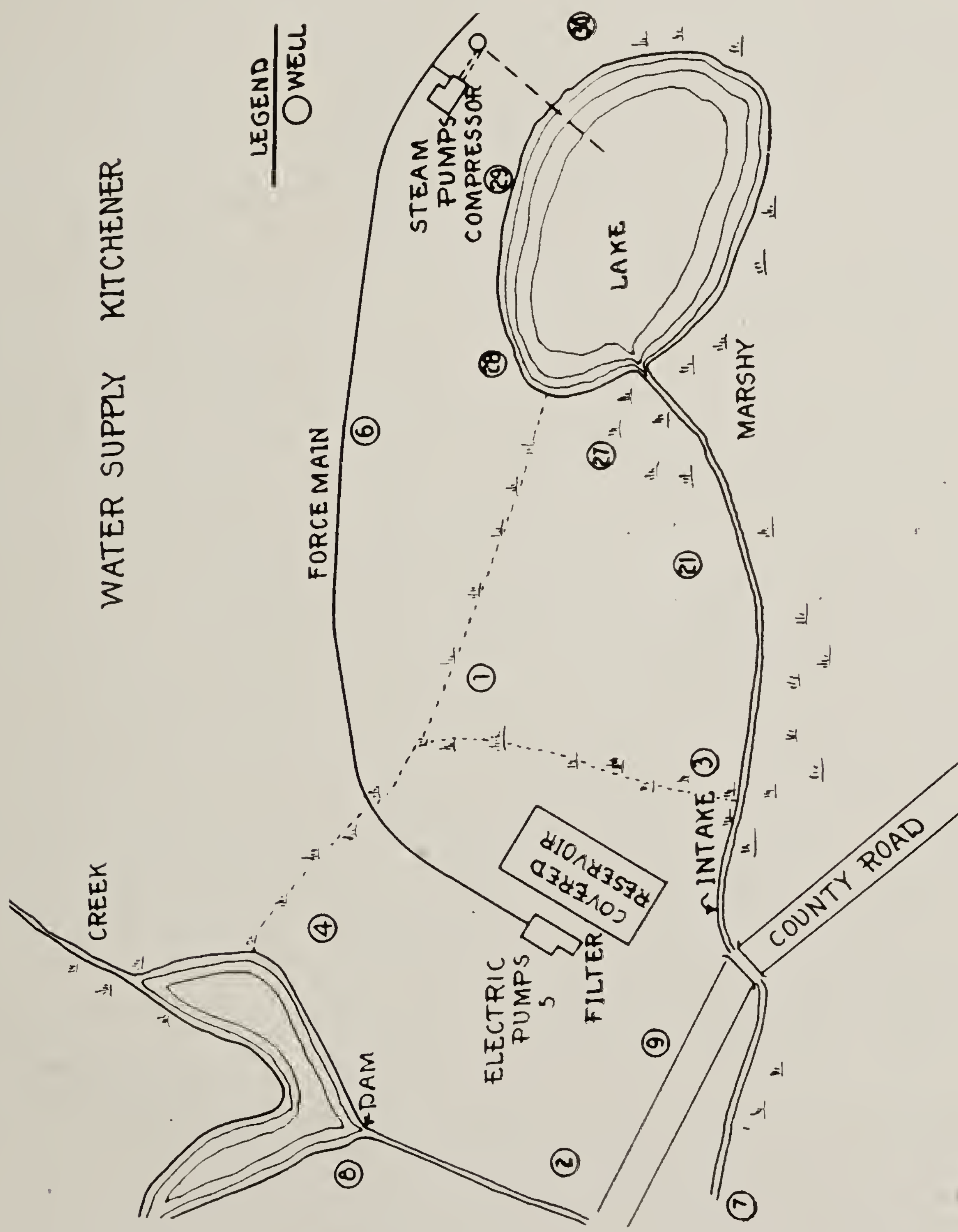
In addition there are several wells at the Glasgow Street pumping station which are driven 360 feet with 8-inch castings, and known to be pure though of extreme hardness.

A mechanical filter was installed at the main pumping station in 1908 having a capacity of 500,000 gallons per 24 hours.

When the filter is in service the Spring Creek arising south or south-west of the pumping station is utilized and feeds the filter after passing through the waterworks pond. The suction for the low lift pump operating the filter is placed in a depression of the overflow creek from the waterworks pond and is protected by some temporary screens of a primitive character.

No precaution appears to have been taken to protect the water supply to the mechanical filter. In the first instance the fences protecting the spring creek area have been neglected and a great many cattle now wander in the valley, polluting the creek to a very considerable degree. This is a matter which should be remedied at once by the repair or replacal of the existing fence, and adjacent property owners should be warned against any destruction of the fences in order to allow their cattle to invade the wet lands.

Records of the well borings made by the late Mr. Bowman show that layers of black soil, gravel, clay, hardpan, sand, clay and sand, quick sand and gravel were encountered. These records are quite complete. From the fact that the gravel


WATER SUPPLY KITCHENER
LEGEND
WELL
STEAM PUMPS COMPRESSOR
LAKE
MARSHY
FORCE MAIN
INTAKE
COUNTY ROAD
COVERED RESERVOIR
FILTER
ELECTRIC PUMPS 5
DAM
CREEK

is found irregularly between the surface and the level from which water is drawn, some connection doubtless exists between the surface in the vicinity of the wells and the wells themselves. This is also borne out by the fact that the water of the waterworks lake is of the same character as that from the wells.

KITCHENER WATER SUPPLY.

Dionic Water Tester:		Conductivity 10° C. Dionic Water Tester.
Well No.	1	310
	2	280
	4	300
	5	300
	7	350
.. Rock well No.	9	800
	23	325
	27	325
	28	310
	29	350
	30	340
W. W. Lake P. H.		350
Overflow of lake at intake		350
Spring Creek		375
Rain water in barrel		30

Bearing this in mind it is but a reasonable precaution to keep the pond and the areas surrounding the wells as sanitary as possible. This has not been done. Cattle have been allowed to wander without restraint in the spring creek supply which has been by-passed through the pond for considerable periods. Also the overflow from the pond has been so poorly provided for that the surface of the ground in the neighbourhood of many of the wells is wet and soggy with many discoloured pools filled with decayed vegetation and frogs.

There is no sufficient reason why the drainage from the waterworks pond cannot be confined to one channel or even to a closed conduit through the area in which the wells are placed, and that all surface water be drained thereto.

I would recommend for the protection of the mechanical filter that a direct connection be had to the waterworks pond and a direct connection to the spring creek, the dams at the spring creek being raised to permit of further storage which would materially assist in both the operation of the filter and in the removal of harmful organisms. Should the Water Commissioners take no action on the above recommendation I am of the opinion that the fencing of the spring creek should be ordered by the Board.

All of which is respectfully submitted.

F. A. DALLYN,
Provincial Sanitary Engineer.

TORONTO, July 22nd, 1916.

RE CAMP PETEWAWA SEWAGE DISPOSAL.

Dr. J. W. S. McCullough, Chief Officer of Health, Toronto, Ont.

SIR,—I have the honour to report upon the marginally noted subject as follows:

Sewage from Camp Petewawa to the extent of from 60,000 to 80,000 gallons per twenty-four hours is discharged after treatment, into the Ottawa River some

ten miles above the Town of Pembroke. Bacteriological examinations made of the Ottawa River water in the vicinity of Pembroke water supply intake, above the same and below Petewawa, indicate that the river is polluted as shown by the repeated presence of B. Coli in the water examined. (*B. Coli is an intestinal organism proper alike to the intestinal track of both man and animal and usually present on pasture lands or fields which have been enriched with barnyard manure.*)

The local authorities have been treating their water supply with hypochloride of lime since 1909, the treatment at that date was resorted to owing to a severe outbreak of typhoid. In addition to the treatment of their water the town has been at considerable expense by reason of moving their intake to a more favourable position above the town. This was primarily for the purpose of getting out of the influence of the back-eddy sweeping up the shore past the town and which carried considerable quantities of Pembroke sewage. Since improving the water supply the local authorities quite naturally look with displeasure upon the discharge of sewage above their intake from the military camp.

Unfortunately there have been occasions when the sewage from the camp has been indifferently looked after. In my opinion the town with the existing protection of its water supply has no occasion to apprehend trouble from the sewage of Camp Petewawa were the Camp treatment adequate. Unfortunately the excellent arrangements for treating sewage at the Camp have not been as effectual as operations of similar apparatus in other localities would lead one to hope for.

ANALYSIS OF CAMP PETEWAWA TREATED SEWAGE.

No.	Location of Sample.	Total Solids	Oxygen Consumed.	Nitrogen.				Chlorine as Chlorides.
				Free Ammonia.	Albuminoid Ammonia.	Nitrites.	Nitrates.	
1	Septic Tank Overflow	234	16	16.7	4.3	None.	.15	40
2	Intermittent Sand-filter Effluent	314	10	15.0	2.8	"	.24	57
3	Ottawa River	46	6	1.7	2.6	"	.25	....

Sample No. 2 shows 95% stability.

The attached analysis shows very little change in the sewage from when it leaves the tanks to when it leaves the drains of the filter beds. The filters should give about 70 to 80 per cent. purification. It would appear that the trouble has been twofold; (1) the tanks were asked to receive the excreta collected from the latrines until a very recent date, which is a duty for which they were not designed. The present method of handling the excreta using shallow trenches and chloride of lime and burying is most effectual and should be continued. (2) The intermittent sand beds owing to the extreme high water of the Ottawa River have been constructed too shallow, and as a consequence the coarse sand now used permits the sewage to flow directly with little more than a coarse screening, to the underdrains.

This is a matter which can be materially improved by deepening the beds, and I would suggest that from 18 inches to 2 feet of sand be taken from the adjacent banks and placed in the existing beds, elevating the feed troughs, and then continue the operation as at present without the use of chlorine as is now practised. The sludge collecting in the tanks should be removed at least yearly, preferably in the spring, and pumped to underdrained sludge beds adjacent to the tanks. These

should be constructed in an approved fashion and so placed that the drainage water will either enter upon the existing sand beds or be lost through absorption in the sand before entering the river.

All of which is respectfully submitted.

Yours very truly,

F. A. Dallyn,
Provincial Sanitary Engineer.

Report Upon Proposed Water Supply for Sault Ste. Marie from Clear Water Creek.

From the Provincial Sanitary Engineer to the Chief Officer of Health for Ontario.

Sir,—I have the honour to report having made a survey of the conditions affecting the proposed Clear Water Creek sourse of supply, a visit to the site having been made on May 10th, 1916, in company with Dr. McCaig, the Medical Officer of Health, Mr. Pickering, Engineer to the Water Commission, and Dr. George, District Officer of Health.

The rate-of-flow measurements in the possession of Mr. Pickering and of which perusal was had during the visit, would indicate that for the period under observation, the past twelve months, the discharge of the springs had at no time been less than eight million U.S. gallons per twenty-four hours. Granting that this year's records may not depict conditions during a dry season, I am of the opinion that the Council would be well advised in accepting the springs as a source of water supply, upon the recommendation of their Engineer, Mr. Pickering, having in mind a reduction of the present water waste.

The water from the springs is clear and sparkling, and from chemical analysis made in our Laboratory at No. 5 Queen's Park, appears to be of excellent quality.

Be the source of the water what it may, there should be no difficulty whatever in properly protecting the springs against surface pollution in their vicinity either from stock grazing on the hills or from mischievous persons camping thereon. The loss of colour between the Root River and the springs gives assurance of sufficient storage to protect against disease producing organisms introduced by the Root River.

This water should not require any treatment by disinfecting agent, provided the springs and storage reservoirs be adequately protected.

It is recommended that sufficient property be acquired so that a distance of 100 feet be had back from the brow of the ravines directly draining into the stream, and having in view this protection it is recommended that surveys be made to determine what properties will require to be acquired.

The property should be fenced in a suitable manner and placards placed at conspicuous points advising against trespassing and stating the reason thereof.

It is further advised that the engineer be instructed to proceed with the drafting of a carefully worded plumbing by-law for the purpose of eliminating unnecessary waste from leaky house fixtures and faulty plumbing, and that a duly qualified plumbing inspector give full time to the work of such a department. Where it is necessary to remodel plumbing, especially in connection with out-door toilets, of which a considerable number have been permitted, sub-section 2, sec. 25,

of the Public Health Act should be taken advantage of in order that the cost of installing the necessary conveniences be made easy as possible to those who, to a certain extent will be put to expense in protecting against a water shortage of the municipality.

It is also suggested that the practice of installing meters be continued with the ultimate intention of metering all services. The cost of meters can be paid for by debentures as is the practice with several municipalities, and spread over a period of not less than ten years.

With reference to the continuance of the existing pumping station, provided that the project of using Clear Water Creek be carried out, I am very loath to advise it. Practically all the severe epidemics in Sault Ste. Marie have come from the water supply, in the first instance being due to gross negligence in the location of the intake in the ship canal, and latterly due either to interruptions in the administration of bleaching powder or from intensive pollution from boats, for which the dosage of chlorine is inadequate, the last being very hard to either control or foresee.

Could all sewage, due either to outdoor privies or workmen about the river above the steel works and the entire sanitary sewage of the steel works and paper mill be carried either by gravity or by a pumping force main below the locks, the water coming from the power canal during the winter months should present no serious menace.

As far as the boat pollution is concerned the recent experience of the city and its past history of typhoid needs no further comment of mine.

Generally speaking the condition of this water could be controlled when used for emergency purposes, provided the dosage of bleaching powder was sufficiently high and available when required: but to my knowledge there is no apparatus now in the market for this purpose, which an engineer would be justified in recommending on sanitary grounds. The whole dependence will be on the operator at this auxiliary plant, and he may be sick when wanted most; the town is then forced to rely upon some local stationary engineer whose knowledge of sanitation may be of no value whatever.

While not entirely dismissing the project of maintaining an auxiliary intake, *I believe it would be advisable to consider it only as a last expedient, and would suggest that an effort be made by the construction of a duplicate pressure main and large storage reservoir, together with a curtailment of water waste, to provide all water required during any heavy draft for fire purposes.*

I am of the opinion that any appropriation passed for acquiring land and proceeding with the pipe line should also include an appropriation for exploration work under the direction of your engineer, to determine something of the nature of the strata underlying the catchment area, and to show what utilization could be made of the existing ravines either on the property of Mr. Ben. R. McMullen as shown on Mr. Pickering's sketch map or the property adjacent damming the lower reaches of the springs, for this purpose if need be. This would decrease to a large extent the amount of sediment in the water conveyed to the reservoirs which, in my opinion, is due largely to the high velocities existing in the creek on account of its rapid fall.

The creek now finding its way in from the Johnston property just north of where the intake location is proposed might be diverted, at no great expense, to Silver Creek, and an earthen dam with clay core wall constructed between the property and Cold Water Creek.

The fluctuating flow in Root River, which lies to the north of the existing

springs and the bed of which is higher than the ground water level in its vicinity was called to by attention. The river undoubtedly loses a great deal of water through this portion of its route, but it is problematical whether the loss of water only takes place at this point and flows to the springs. I am rather of the opinion that if surveys were made it would be found that the ground water in the path of the Root River is considerably lower than the river bed and that water is lost over a considerably larger area than the gravel pit. It is, however, possible to determine this by survey, and also to determine whether the gravel stratum feeding the springs extends to and forms part of the area fed by the river immediately north of the source of the westerly branch.

All of which is respectfully submitted.

F. A. Dallyn,
Provincial Sanitary Engineer.

May 18th, 1916.

Report Upon the Water Supply and Sanitation at Rockland, Ontario.

Rockland is a small town on the banks of the Ottawa River some twenty-seven miles by river below Ottawa. The town is largely dependent upon the Edwards Lumber Mills and upon a considerable farming community throughout the County of Prescott.

An examination was made into the water supply on May 3rd, 1916, for the purpose of determining as to whether the water supply which was installed by the Edwards Company for fire protection solely, was being used for domestic purposes. It would appear that by the original agreement it was contemplated to furnish a pure water supply, but inquiries on the part of the Company, showed this would involve the use of filters and some supervision which they were reluctant to undertake. The matter then resolved itself into providing a fire supply and the town now pays a rental of $490.00 per annum for 49 hydrants. Since the system was installed practically the whole of the town, with the exception of East Rockland, have connected to this fire protection system and are using it for all purposes. The water unquestionably is seriously polluted as was shown in analyses made on July 9th, 1915.

There has been no effort on the part of the town or the Company to have this water periodically examined; the only samples received are those submitted on March 20th, 1913, and July 9th, 1915, respectively, upon instructions from this office.

The number of deaths from typhoid in Rockland since the installation of the system has reached a considerable figure, the rate being much higher than that existing in the other parts of the County and in Hawkesbury, which is considerably farther down the river and more remote from the Ottawa sewage. At the time of the severe epidemic of typhoid in Ottawa in 1912, Rockland experienced a severe outbreak a few weeks later, there being forty cases reported in the month of September. Undoubtedly there were more cases than these and the town received a certain immunity consequent upon the wide-spread epidemic. In 1915 the town experienced another outbreak reporting ten cases in the month of February. It is most improbable that this could have arisen from any source other than water or milk; from the character of the milk supply it seems most improbable that an

outbreak of this size could be contributed to this cause, especially in view of the fact of the constant serious pollution of the water. During this year (1916) there have been a great many cases; 11 cases were reported in the month of February alone.

Upon inquiry among the doctors in Rockland it was learned that for the years 1915 and 1916 (up to May 2nd) no less than some 57 cases have been treated in the town. This is altogether abnormal and cannot be overlooked save at considerable peril to the County, whose typhoid death rate, I believe, has been seriously influenced by the existence of this focus of infection at Rockland.

The second matter of serious moment in Rockland is the unusually high infant death rate from intestinal disorders reported in our vital statistics as Class 104, Diarrhœa and Enteritis. During the last three years, viz., 1913, 1914 and 1915, the loss in Rockland from this cause alone has amounted to 13.7 per cent., 13.1 per cent. and 17.9 per cent. respectively, of the births. Dr. Powers, the Medical Officer of Health, suggests that this may be largely due to irrational feeding of the infants by the French-Canadian mothers, as the babies, while being breast-fed and less than six months old, are given all sorts of auxiliary food. This undoubtedly is part of the trouble, but does not explain the fact that while the death rate in Rockland is so high, the average death rate in the neighboring county from this cause is only 2.87 per cent. of the births and the exceptional years only show 4.4 per cent. This, I believe, is sufficient evidence to show that supplementary feeding is not the only cause of Rockland's high infant death rate.

On the other hand we find that there is considerable congestion of the population in Rockland and that in most of the sections it must be in excess of thirty-five persons per acre. The town has offered no sewerage service whatever and the conveniences are all of the out-door privy type. Here again the town has been negligent and no effort appears to have been made towards standardizing the receptacle or supervising the screening of the conveniences to prevent flies having access to the contents thereof, during the summer months. In certain sections of the town flies are very prevalent in the summer and must cause considerable nuisance in addition to the transference of infective matter to the infants' mouths. Their infant deaths largely take place in the months of July, August and September, months when flies are most prevalent.

Financially, the town itself is in excellent condition, the Department of Agriculture reporting that in 1915 their debenture debt only amounted to $4,614.00, which was for schools. The town, therefore, is in a position to undertake (1) purification of the water supply and the handling of same on some intelligent basis, (2) construction of certain sewers, (3) regulation of the type of outhouse to be permitted, together with the compulsory enforcement of screening and protection against the ingress of flies or the breeding of them in such premises.

During my visit there I had the pleasure of meeting the council and there appears to be an intelligent desire on their part to improve local sanitary conditions, especially by the installation of filters for the water supply and the construction of certain sewers. The Council, however, lack initiative but have, I believe, for years been largely influenced by the direction of Senator Edwards, through whose efforts the town has all the outward semblance of a prosperous centre. I have inquired into the probable cost of filters to meet with the town's present requirements and am convinced that it will not exceed $9,000.00, including housing of the required equipment. Such an expenditure will only involve the town in an annual expenditure of about $760.00 for interest and re-payment of principal. The construction of sewers will be considerably more costly, but owing

to the topography of the town, can be laid at a minimum of expense with the exception of certain sections which will have to be constructed in rock.

I have the honour to recommend that the Town of Rockland be urged to instal pressure filters with the addition of chlorination for protecting their water supply which undoubtedly is the main source of their typhoid, and, I am of the opinion, responsible in a secondary manner for a great deal of their diarrhœa and enteritis amongst infants. The town will undoubtedly save money by this step owing both to the lessening of typhoid and to the attractiveness of the water supply, which then can be put upon a paying basis and assessed like other local improvements. The regulation of type of outhouse is also necessary. By-laws similar to that suggested in our pamphlet on Sewage Disposal should be passed and a standard type of outhouse should be required for new premises, together with the effective screening and protecting of existing ones.

With reference to the serious pollution in the Ottawa River I beg to submit that the same is caused by sewage of the City of Ottawa and of the City of Hull. To just what extent either is responsible it would be difficult to determine. In the spring Rockland is not more than twenty-four hours by river flow from Ottawa or Hull. Consequently there is very little opportunity for storage of the sewage permitting infective organisms to disappear either by longevity or by sedimentation, the current in this section of the river being in excess of two miles per hour in many sections. In summer, with low water and a lessened stream flow the conditions are not materially improved, so that at all periods of the year adequate protection of the water will be required. By reason of the very large amount of sewer construction required before the sewage of Ottawa could be collected and treated at a central point or a series of points, and owing to the fact that we have no jurisdiction whatever over the City of Hull in Quebec, I am of the opinion that it is entirely futile to wait until such time as the pollution is corrected at its source. While it is unfortunate that from a public health standpoint, a smaller community should suffer through aggressiveness of a larger one, yet under such circumstances, the smaller one must be compelled to protect itself by an expenditure of its own moneys.

All of which is respectfully submitted.

F. A. Dallyn,
Provincial Sanitary Engineer.

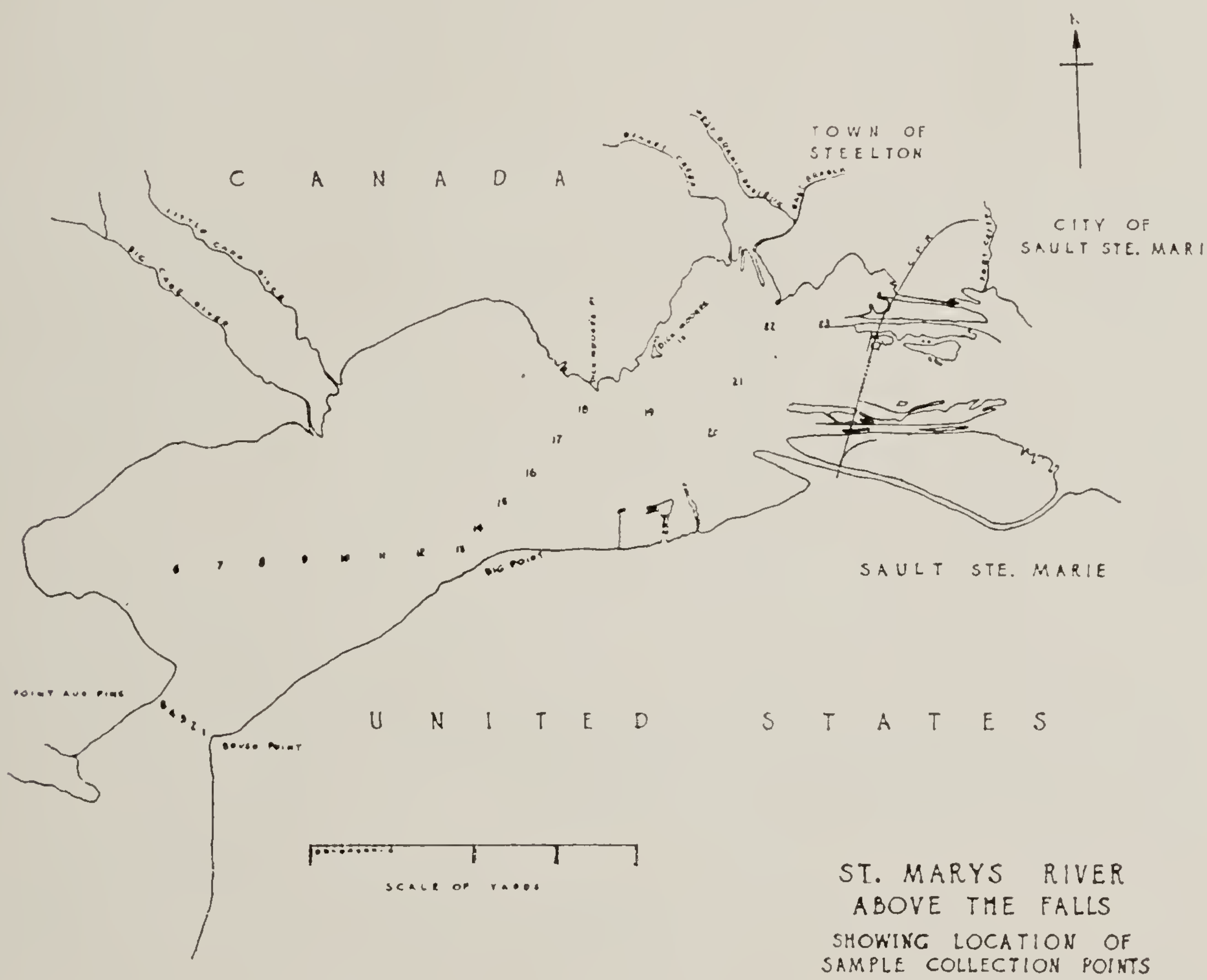
Report re Water of Upper St. Mary's River.

Toronto, October 21st, 1916.

Dr. J. W. S. McCullough, Chief Officer of Health, Ontario, Parliament Buildings, Toronto.

Dear Sir,—In accordance with your instructions I went to Sault Ste. Marie on October 9th, 1916. The City Council had appointed a committee of three aldermen—Dr. McCaig, Medical Officer of Health, and Mr. Van Every, the City Treasurer—to supervise and oversee my work. On October 17th, Dr. McCaig, Mr. Van Every, Alderman Spiers and myself went up the St. Mary's River as far as Point aux Pines. Samples were taken at the points marked in the accompanying

blue print. The day was clear and cold with a fresh northerly breeze. Fourteen vessels were passed in the river. Some of these had been storm-stayed for a couple of days. The samples taken were mostly at a depth of twenty feet. In shallow places, however, the samples were taken two feet from the bottom. The bacteriological examination of the samples was carried out, following the standard methods of the Ameiican Public Health Association.



The results were entirely in accordance with those obtained by the International Joint High Commission in 1913, and showed a dangerous and general pollution of the Upper St. Mary's River. Every sample but one showed B. Coli in 25 c.c.; 6 samples showed B. Coli in 5 c.c. and sample No. 10 showed its presence in 1 c.c. This indicates a fairly even distribution of the pollution throughout the river. This was due no doubt to the mixing by the high winds which had prevailed for several days.

Bacteriological Analysis re Water of Upper St. Mary's River.

Samples	Depth in feet.	Count 37°	Fermentation.		B. Col.	
			1 cc.	5 cc.	25 cc.	50 cc.
1	10	5	0	0	+	+
2	17	37	0	0	+	+
3	20	4	0	0	+	—
4	20	8	0	0	+	+
5	20	2	0	0	+	+
6	10	11	0	0	0	+
7	5	10	0	0	+	+
8	20	2	0	0	+	+
9	20	1,000	0	0	+	+
10	20	3	+	+	+	+
11	20	600	0	+	+	+
12	5	2	0	0	+	+
13	31	24	0	0	+	+
14	5	1,200	0	0	+	+
15	20	3,000	0	0	+	+
16	20	9	0	+	+	+
17	15	2	0	0	+	+
18	11	1,400	0	0	+	+
19	20	3	0	0	+	+
20	12	1,500	0	+	+	+
21	22	24	0	0	+	+
22	22	9	0	0	+	+
23	22	3,500	0	+	+	+

The bacteriological analysis of the samples, together with a blue print showing the location of the samples, are included herewith.

All of which is respectfully submitted.

A. V. DeLaporte,

Chemist in charge of the Experimental Station.

Report re Orillia Water Supply.

Toronto, July 22nd, 1916.

Dr. J. W. S. McCullough, Chief Officer of Health, Ontario, Toronto.

Sir,—Acting on your instructions I visited Orillia on June 9th to investigate the operation and efficiency of their filter unit.

Unit.

The unit consists of five filters 16 ft. x 8 ft. of the pressure type. The filtering media is quartz sand of an effective size of 0.428 and a uniformity co-efficient of 1.6.

Operation.

The filters are used about 9 hours daily, from 4.30 a.m. until 7.30 a.m., from 9.30 a.m. until 11.30 a.m., from 2 p.m. to 5 p.m. and from 8 p.m. to 9 p.m. About every third day the filters are washed, air being blown through them for five minutes, then water for eight minutes. After washing the effluent is run to

waste for about five minutes before being turned into the town mains. The quantity of alum used was one grain per gallon; one-third being added before the water enters the sedimentation tank, one-third in the pump well and the remainder in the pump itself.

Research With Filters.

After washing filter "E" the manhole cover was removed and a sample of the sand was taken for analyses. A heavy growth of algae was observed in the sand.

Bacterial examinations of the low water, the water in the pump well and the effluent from the different filters on starting, namely:

10 minutes after starting
20 minutes after starting
½ hour after starting
1 hour after starting, were made.

These showed that the bacteriological efficiency of the filters was poor—50 per cent. of the organisms growing at 18 degrees, 95 per cent. of the organisms growing at 37 degrees and 90 per cent. of the B. Coli (estimated by the Phelps method) were removed during the treatment.

The result showed also that the bacterial counts at 18 degrees in the effluent from the filters was actually greater than the bacteriological counts in the influent from the pump well, and that the removal of the organisms growing at 37 degrees was only 43 per cent. and with a B. Coli removal of 87 per cent.; the remainder being the major portion of the removal having taken place in the sedimentation tank. The counts also show that the beds were infected with organisms growing at 18 degrees.

This low bacterial removal led to an investigation of the filter media. The filter was washed thoroughly and the manhole cover removed and a sample of the sand taken for mechanical analysis. A visual examination of the sand disclosed a heavy growth of algae. An analysis of the sand showed that it was of good filter size, the effective size being 0.428, the uniformity co-efficient 1.6.

Filter "D" after the removal of the sand was put in operation again and samples of the effluent and influent were taken for five minutes. These samples showed that the filter was slow in picking up its efficiency. The count in the effluent invariably being higher in the effluent than in the influent. This gave further evidence of the infection of the filters.

A mechanical examination of the raw water, the filter influent and filter effluent immediately after washing, 10 minutes after washing and 30 minutes after washing proved that the smutzdecka was slow in forming. Alum over and above that naturally in the water being present in the effluent 10 minutes after filtration had commenced. The filters mechanically seemed in good condition.

Why the efficiency of the filter was so slow seems to be due:

1st.—The slow forming of the smutzdecka primarily.

2nd.—To the distribution of the smutzdecka during the period when filters are standing.

3rd.—To the infection of the filters themselves.

From the data collected it would seem that the coagulant added was insufficient. This taken together with the operation of the units (the operation is certainly no standard practice) would lead to a distinct lowering of the efficiencies.

LABORATORY EXAMINATION ORILLIA WATER SUPPLY. JUNE 10, 1916.

CHEMICAL.

	Raw Water.	Pump Well.	Filter After Wash.	Filter "E" 10 Minutes After Wash.	Filter After 30 Minutes' Operation
Total Solids	156.0 ppm.	161.5	162.5	156.0	160.5
Losses on Ignition	62.0	61.0	64.5	58.0	71.0
SiO_2	....	....	....	1.0	....
SO_3	....	9.0	7.0	5.0	7.0
$CaSo_4$	....	....	....	....	....
Fe_2O_3	0.5	0.5	0.5	0.5	0.5
Al_2O_3	1.0	5.0	4.5	2.0	1.0
Cal	56.5	58.5	63.5	62.0	57.5
Cl	3.0	2.0	2.0	3.0	2.0
MgO	18.5	9.2	13.2	9.5	10.0
Na_2O	4.4	10.0	7.5	9.0	9.0
K_2O	....	....	0.5	1.5	....
CO_2	70.0	60.0	69.0	63.5	60.6
Alkalinity	128.0	120.0	126.0	117.0	115.0
Alum	....	0.8 grs. per gal.	....	0.4 grs. per gal.	0.2 grs. per gal.

BACTERIOLOGICAL.

Water.	Source of Samples	Counts.		No. c.c. 1 cc.	B Coli.				Time.
		18°-22°	37°		5 cc.	10 cc.	25 cc.	50 cc.	
Raw.	1	52	12	+	+	+	+	+	9.58
	2	22	Spr.	+	+	+	+	+	10
	3	27sp	28sp	+	+	+	+	+	10.10
	4	28	14	+	+	+	+	+	10.40
In Pump Well.	5	1	29	+	+	+	+	+	9.50
	6	18	8	+	+	+	+	+	10.
	7	15	23	+	+	+	+	+	10.10
	8	500	560	+	+	+	+	+	10.40
Effluent Filter "A"	9	3	4	0	+	+	+	+	9.58
	10	1	10	0	0	0	+	+	10.
	11	Spr.	2	0	0	+	+	+	10.10
	12	Spr.	1	0	0	0	0	+	10.40
	13	4	0	0	0	+	+	+	11.40
Effluent Filter "B"	14	3	0	0	0	0	+	+	Do.
	15	25	2	0	0	+	+	+	
	16	0	0	0	0	+	+	+	
	17	32	5	0	0	+	+	+	
	18	29	1	0	0	+	+	+	
Effluent Filter "C"	19	Spr.	1	0	0	+	+	+	Do.
	20	Spr.	0	0	0	0	+	+	
	21	1	1	0	0	+	+	+	
	22	2	0	0	0	0	+	+	
	23	Spr.	0	0	0	+	+	+	
"D"	24	1	1	0	0	0	+	+	Do.
	25	2	1	0	0	+	+	+	
	26	2	0	0	0	+	+	+	
	27	2	2	+	+	+	+	+	
	28	3	1	0	0	+	+	+	
"E"	29	4	0	0	0	+	+	+	9.50
Influent Filter "E"	30	2	1	+	+	+	+	+	On starting.
	31	Spr.	0	0	0	+	+	+	5 minutes.
	32	2	0	+	+	+	+	+	10 "
	33	1	0	0	0	+	+	+	15 "
	34	9	0	0	0	+	+	+	20 "
	35	3	1	0	0	+	+	+	25 "
Effluent Filter "F"	36	10	1	0	0	+	+	+	On starting.
	37	Spr.	Spr.	0	0	+	+	+	5 minutes.
	38	37	2	+	+	+	+	+	10 "
	39	11	1	0	0	+	+	+	15 "
	40	6	9	0	0	0	+	+	20 "
	41	14	2	0	0	+	+	+	25 "

Note.—In all cases spreaders were Agar liquefiers.

ANALYSIS OF SAND FOR FILTER "E"—ORILLIA WATERWORKS.

Sieve Marked	Size of Mesh in MM.	Quantity of Sand Passing in Grams.	% of Total	Sieve Marked.	Size of Mesh in MM.	Quantity of Sand Passing in Grams.	% of Total.
200	0.074	0.076	0.076	80	0.215	0.214	0.214
170	0.106	0.096	0.096	70	0.257	0.521	0.521
140	0.124	0.123	0.123	40	0.39	4.791	4.791
120	0.139	0.13	0.13	20	0.769	79.396	79.396
100	0.169	0.18	0.18	10	2.198	99.995	99.995

Conclusion.

(*a*) A vigorous cleaning with copper sulphate or bleaching powder would remove the algae growth and the infection in the filters.

(*b*) The filters should be washed every morning before being used for the day—5 to 8 minutes washing would be sufficient—air not being necessary.

After washing the filters the filtrate should be run to waste for at least 10 minutes in order to give sufficient smutzdecka for filter purposes time to form.

(*c*) The amount of coagulant being added is insufficient and should be nearly doubled.

The alkalinity results are appended.

All of the above is respectfully submitted.

A. V. DeLaporte,
Chemist in Charge of Experimental Station.

Report Orillia Water Supply.

Toronto, July 22nd, 1916.

Dr. J. W. S. McCullough, Chief Officer of Health, Ontario, Toronto.

Sir,—On July 4th I made a sanitary survey of the source of the Orillia water supply. This was deemed necessary on account of the bacteriological results obtained in the previous visit June 9th. The following interesting facts were disclosed:

(*a*) Slavin's Creek which empties into Lake Couchiching immediately south of the C.P.R. cattle pens contains a large quantity of sewage. The sewage in the creek amounts to about 150,000 to 200,000 gallons per day. This comes from leaks in the force main to the sewage disposal farm.

(*b*) Slavin's Creek flows directly over the Orillia intake pipe about four (4) hours after entering the lake.

(*c*) That the privies and bathing houses in Couchiching Beach Park, about 100 yards from the pump-house, have no safeguards to prevent drainage from excremental matter reaching the lake in the immediate vicinity of the intake pipe.

(*d*) That the water from the bathing beaches at Couchiching Beach Park flows directly over the intake pipe.

A series of tests with floats proved that the current from Slavin's Creek passes over the Orillia intake pipe four to five hours after entering the lake. The comparative freshness of this pollution renders it doubly dangerous. The Corporation of the Town of Orillia are taking steps to prevent this unnecessary pollution.

The creek should be diverted and as much as possible made to flow into Lake Simcoe, and the remainder should be treated as ordinary sewage and pumped to the disposal works. The leaks in the sewer line from the sewer pumping station to the disposal works should be repaired and further leaks guarded against. The bathing houses in Couchiching Beach Park should be removed as far as possible from the pump house, and the privies at present in those bathing houses are distinctly unsanitary and should be done away with and proper sanitary conveniences with water-tight containers installed.

All of which is respectfully submitted.

A. V. DeLaporte,
Chemist in charge of Experimental Station.

Report re Smith's Falls Water Supply.

Toronto, July 22nd, 1916.

Dr. J. W. S. McCullough, Chief Officer of Health, Ontario, Toronto.

Sir,—Acting on your instructions I made sanitary survey of the source of Smith's Falls water supply on July 20th with a view to the chlorination of the supply.

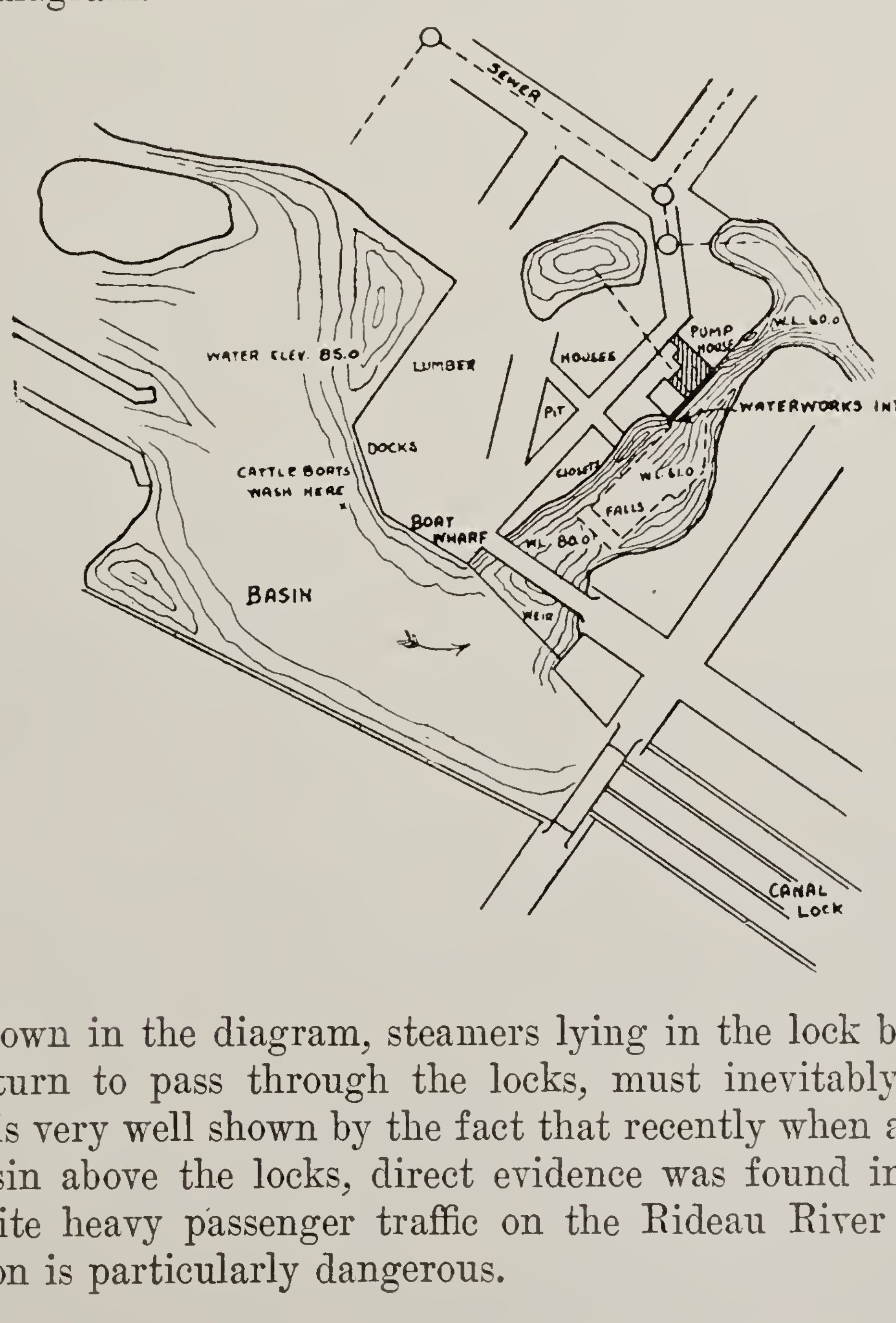
The intake pipes are laid into a flume which leads directly from a lock basin above the falls. The water, which is seriously polluted, receives its pollution from three distinct sources:

(1) Privies located on the banks and in the boat houses.

(2) Steamers.

(3) Sewage from the Town of Perth which is emptied into the river about 10 miles above Smith's Falls. As the current of the river is about 2 miles an hour, it is possible for this sewage to reach Smith's Falls in about 5 or 6 hours.

(*a*) There are at least three privies located above the falls. These privies are within 100 yds. of the intake pipe. The ground on which they are situated has been made by filling in with large rocks. The fissures between the rocks are filled with water and form a direct connection to the river, giving the drainage from the privies direct entrance to the current and to the lock basin from which the town takes its supply. Added pollution from the steamers at the coal docks, etc., must also be carried by the current directly to the intake. This is very well shown by the accompanying diagram.



(*b*) As shown in the diagram, steamers lying in the lock basin above the falls waiting their turn to pass through the locks, must inevitably pollute the water supply. This is very well shown by the fact that recently when a cattle boat washed ship in the basin above the locks, direct evidence was found in the water supply. As there is quite heavy passenger traffic on the Rideau River at this point such direct connection is particularly dangerous.

Bacterial examination of this water showed counts of 125 per cc at both 18 degrees centigrade and 37 degrees centigrade, and the presence of colon bacilli 1cc.

That such a condition of affairs should exist is incredible, and immediate action is necessary to forestall a water borne epidemic. Chlorination, as a temporary measure, should be resorted to without delay. To chlorinate, it will be necessary to pump the chlorine solution into the pipe line outside the pump-house. At least 20 lbs. of bleaching powder per million gallons should be used, making a total of about 50 lbs. per day.

All of which is respectfully submitted.

A. V. DeLaporte,

Chemist in Charge of Experimental Station.

Report re Strathroy Water Supply.

Toronto, September 21st, 1916.

Dr. J. W. S. McCullough, Chief Officer of Health, Ontario, Toronto, Canada.

Sir,—Acting under your instructions I visited the Town of Strathroy on Wednesday, September 20th and made a sanitary survey of area likely to affect the wells that they proposed to use for the water supply. The water supplying the wells flows from a layer of quick sand through which all ground water finds its outlet to the river.

The soil at Strathroy is of a light sand nature. The town is without sewers. New houses having flush closets installed use septic tanks which drain into the soil, and those who have not flush closets have the old-fashioned unprotected pit privies draining into the ground and are unsanitary in the extreme.

The wells are located about 160 feet from a row of houses having pit privies and are between them and the river. Consequently, even if a few bacterial examinations of the water should indicate the absence of intestinal organisms, a sanitary survey of the surrounding district shows that the water would be of exceedingly doubtful character.

The present water supply of Strathroy is taken from the Sydenham River. In the pond from which the water is taken masses of fæces can be seen floating about at any time. What is supposed to be a surface drain, but really constitutes a sewer taking the sewage from the Queen's Hotel and other places, empties into this pond at the foot of Frank Street within thirty feet of the intake pipe; a back eddy carries the waste material and excremental matter immediately over the intake pipe. A sample of water taken at the intake pipe was found to contain large pieces of horse droppings and small pieces of human excrement.

While it is claimed by the town authorities that this system is used only as a fire supply and is not to be used for domestic purposes, the fact is that the water is served to the guests at The Queen's Hotel from taps, and I observed at least two different people drinking the water. I also received information that the dentists used this water for washing the mouths of their patients without any treatment whatever. The several members of the Town Council stated that they had several times seen children drinking this water from the taps. Such a condition is intolerable. As most of the pollution in the stream from which the water supply is taken occurs within the sanitary jurisdiction of the Strathroy Board of Health there appears to be no excuse for this gross carelessness.

In addition to the above pollution there are closets emptying into the river together with two or three town drains above the intake pipe. Upon being informed of this fact Dr. McAllister defended his refusal to take any action by the question, "Why should Strathroy be obliged to take action when other municipalities were allowed to drain their sewage into provincial waters?"

The Mayor, Mr. Graham, Mr. Smithrim, Chairman of the Water Commission, and other members of the Council were quite favourable to the improvement of the water supply, and in my opinion the time is ripe for Strathroy to instal a proper water plant, together with sewers and sewage disposal works.

In the meantime chlorination of this supply which is so carelessly supervised is imperative. The Medical Officer of Health should notify citizens who use this water of its most dangerous character.

All of which is respectfully submitted. A. V. DeLaporte,

Chemist in Charge of Experimental Station.

Toronto, December 26th, 1916.

Dr. J. W. S. McCullough, Chief Officer of Health, Ontario, Toronto, Ont.

Sir,—Acting on your instructions I visited the police village of Westboro on December 19th in company with Dr. Moloney, District Officer of Health.

The City of Ottawa were complaining that a ditch known as the Cummings Award ditch was endangering their water supply. In addition to the question of the Ottawa water supply there was a claim of Mr. Hill to be investigated regarding the pollution of his well by his neighbour's septic tank. These two complaints are founded on the same conditions and can be very well dealt with as one.

The Cummings Award ditch is a draining scheme to carry off the surface water from part of the Township of Nepean and the Police Village of Westboro. It is simply a surface drain carrying the run-off from an area one and one-half miles long by one-half mile wide. This area includes, in addition to the Police Village of Westboro, part of the Township of Nepean. The population of the above area is about 1,500 people. As there are no sewers most of the residents have old-fashioned privies and sanitation in some parts is primitive. In other sections the residents have automatic electric pumps and flush closets, disposing of the sewage by septic tanks and tile drainage. As a consequence of the number of people on this drainage area the surface water in the Cummings Award ditch is seriously polluted and emptying, as it does, into the Ottawa River about two miles above Ottawa waterworks intake, constitutes a serious menace to the health of the City of Ottawa.

The Cummings Award ditch, however, is not the only drain emptying into the river in this vicinity. The district between Ottawa and Britannia has been subdivided into building lots and the sub-divisions have been fairly well built up. The population in this section is estimated to be 4,500 people, and numerous drains carrying surface water and, in some instances septic tank effluents, empty into the river at various points along this shore.

To handle the situation a comprehensive scheme of sewers and sewage disposal is required. Either the residents of Westboro and the adjacent sub-division will have to organize a municipality and put in proper water service, sewers, etc., or the City of Ottawa will be obliged, for its own protection, to annex the district and run a trunk sewer along the river to collect all the drainage.

The investigation into the pollution of Mr. Hill's well showed a most serious condition to exist. The sub-division of Highland Park in which Mr. Hill lives is built up with houses costing $3,500 and upwards, and is sub-divided into lots 60 ft. x 100 ft., although in most instances the frontage is two or more lots. The only drainage in this section is by farm tile drains leading to the river. These drains are supposed to carry only surface water but connections are had to nearly all the cellars, some wash tubs and, in one case at least, the over-flow from a septic tank. If thorough investigation were carried out it would probably be found that flush closets also are connected.

The residents in the sub-division get their water from wells on their own lots and dispose of their sewage on the same lot, usually by septic tanks and tile drains. The few who have not installed flush closets generally use old-fashioned privies. As a result of this condition the ground water is heavily charged with sewage and it will be a matter of surprise to me if any well in this district is free from contamination. No bacterial results were obtainable for the wells in this district and it was impossible to ascertain the prevalence and extent of the pollution, but the situation is extremely grave.

Active measures should be taken at once to secure pure water and proper sewage disposal for this section.

In regard to the pollution of Mr. Hill's well, he maintains a privy which is certainly not water-tight within twenty feet of his well, and cannot very well put the entire blame on his neighbours. Further, as there are three septic tanks within 100 feet of his well it is impossible to blame any particular tank for the pollution, but in my opinion the removal of any or all of the tanks in this block would not render Mr. Hill's well safe for drinking.

The time is ripe for a main drainage scheme and water services for that section of country lying between the City of Ottawa and Britannia. The population of this section totals over 10,000 people. The surface drainage reaching the river from this section is undoubtedly heavily polluted and it would be absurd to take steps to remedy the pollution from one ditch and permit others as bad if not worse to continue to empty their filth into the river. If the residents of this sub-division will not organize and solve the problem themselves, the Municipality of the City of Ottawa will be forced, for its own protection, to annex the district and handle the situation as outlined.

All of which is respectfully submitted.

A. V. DeLaporte,
Acting Provincial Sanitary Engineer.

Report Owen Sound Water Supply.

Toronto, May 22nd, 1916.

Dr. J. W. S. McCullough, Chief Officer of Health, Ontario.

Sir,—Acting under your instructions I went to Owen Sound on Tuesday evening, May 16th, and spent the following two days investigating the condition of the local water supply. There have been 28 cases of typhoid, 9 cases of paratyphoid and 3 deaths reported in the last month. After investigating and in conference with Dr. A. B. Rutherford, Medical Officer of Health, as to the cause of the recent epidemic it was decided:

1. That the epidemic was not preceeded by an outbreak of diarrhœa.

2. That in all probability the so-called paratyphoid and typhoid were from the same source. All the cases being either paratyphoid or typhoid.

3. That the epidemic had been caused by the casual pollution of the springs which formed the original source of supply for the Town of Owen Sound.

It was shown that the milk supply was not the cause of the epidemic as no one dairy had been the source of supply for all the cases. Every dairy in town had typhoid cases amongst its customers.

Another fact that made the springs the subject of suspicion was, that, while there are two distinct water systems in the town from entirely different sources, all the cases were in that part of the town served by the spring water system, or employed in that part of the town during the day.

A bacterial examination of the different waters used in the town located the trouble in the spring known as the Creamery Hill Spring.

Sources of Water Supply.

Owen Sound has two distinct water systems—the low pressure system which was the original source of water supply for the town is supplied from four distinct springs. The water flows by gravity to a reservoir near the top of the "East" hill. This supply is for the main part of the town. Spring No. 1, or "Creamery Hill" spring rises at the side of Creamery Hill road; its flow being approximately 200,000 gallons per diem. It was the original source of water supply for Owen Sound. The purity of this spring being questioned twenty or more years ago the presence of drainage water in it was proven by adding phenyl to various pools in the neighbourhood. The presence of phenyl in the town water supply proved conclusively that surface water was finding its way into the spring. Steps were taken to prevent this pollution by digging an expensive drain, but at the time of my visit it was quite evident to even the most casual observer that a small stream which serves as a surface drain for some parts of the country was finding its way through fissures in the rock into the spring and must have added considerable to its volume. It is probably here that the pollution which was the cause of the epidemic occurred, although there is no record of sickness in the surrounding country. Creamery Hill road is well travelled and the stream acts as a drain for some miles. A chance traveller may have been the cause of the trouble. There was a death, in the latter part of March, from typhoid. The man was a butcher and buyer of cattle travelling extensively around the country and had been sick for some weeks before his case was diagnosed as typhoid—and he probably used this road continuously. A bacterial examination showed the spring to be positive in 25 c.c. the streams in 5 c.c. Owing to the character of the rock it would be difficult if not impossible to safeguard this spring. It would, therefore be safest in my opinion to cut this spring off from the water supply permanently.

Springs Nos. 2, 3 and 4 rise in a ravine near Ingles Falls. These are supposed to have their source in Sydenham River above the town dam. That this is the case is easily understood owing to the fissured character of the rocks, but that all the water does not come from the Sydenham River is shown by the fact that while the head of water in the river is practically constant, owing to the regulation by the dam, there is considerable variation in the flow of the springs, showing that a certain amount of the water is finding its way to the springs, and while they seemed to be perfectly pure at the time of my visit the fact of surface water being present will necessitate a constant bacteriological supervision of the water from these sources.

The water in the high pressure system is secured from the Sydenham River above Ingles Falls. Here the town has erected a dam to keep the water level constant. The water flows by gravity in a 2-foot glazed pipe (which is practically on the surface of the ground and is in rather poor condition) between a couple of cottages with their accompanying privies to two slow sand filters. Each of the filters is 160 ft. x 80 ft. and is made up of 1½ ft. of broken stone, 3 ft. of sand and operates on a head of 4 ft. The filter water flows by gravity to the high pressure reservoir about 100 yards from the old reservoir and 50 ft. or more higher. The filtered water has proven good whenever examined. There was no means of determining the rate the filter was operating at as the Venturi meters had been allowed to get out of repair, just gross carelessness. Each filter is capable of filtering 1,000,000 gallons per diem, but at the time of my visit only one filter was in operation and it was estimated to be filtering about 700,000 gallons per day. As the town uses over 1,200,000 gallons per day it would be necessary for the town if filtered water alone were used, to buy another 1,000,000 gallons of water per day from Mr. Ingles and operate both filters.

The Reservoirs.

The high pressure reservoir is a concrete basin holding about 5,000,000 gallons and is well above the level of the surrounding country. This is in fine condition.

The old reservoir, however, lower down the hill should be regarded with suspicion. Above the reservoir on the hill are numerous dwellings, none of which have sewer connections and most of which have pit closets.

Field Laboratory Reports, Owen Sound.

Sample No.	18°-22°c. Count per cc.	37°c. Count per cc.	Colon (presumptive test).					Current Notes.
			1 cc.	5 cc.	10 cc.	25 cc.	50 cc.	
1	400	15	0	0	......	+	+	Sydenham River, above Falls.
2	1	0	0	0	......	0	0	Pure Water Reservoir.
3	0	0	0	0	......	0	0	No. 2 Spring.
4	1	0	0	0	......	0	0	No. 3 Spring.
5	0	0	0	0	......	0	0	No. 4 Spring.
6	60	5	0	0	......	+	+	Creamery Hill Rd., Spring No. 1.
7	145	5	0	+	......	+	+	Spring known to pollute No. 1.
8	35	0	0	0	......	+	+	Ground water suspected of seeping into old reservoir.

A spring rises in the centre of the reservoir. As the ground water on the hill is polluted with excremental matter and the bed rock is badly fissured the spring is probably polluted from time to time. This would render the continued use of this reservoir doubtful unless precautions were taken to prevent pollution of the reservoir by this spring.

Summary.

1. Epidemic caused by pollution of Creamery Hill Spring.
2. Continued use of No. 1 Creamery Hill is dangerous. It should be permanently disconnected from the supply.
3. Springs Nos. 2, 3 and 4 are apparently pure, but a constant bacteriological supervision should be maintained.

4. The filters are operating in a satisfactory manner, but the Venturi control should be repaired and kept in working order.

5. The high pressure reservoir is in good condition.

6. The low pressure reservoir should not be used until ample precautions have been taken to prevent its pollution by ground water from the hill above.

The town should exercise sanitary control under Sec. 93 of the district for one mile on each side of the Sydenham River extending from the town to a point a mile above the town dam. They should compel the use of proper water-tight containers in the closets, and proper disposal of excremental matter. At Ingles Falls where there are several houses with water systems a proper system of disposing of the waste water should be installed to prevent any waste water finding its way into the fissures of the rock and ensure its return to the river after suitable treatment.

All of the above is respectfully submitted.

A. V. DeLaporte,

Chemist in Charge of Experimental Station.

Report re Napanee Sewage Disposal System.

Dr. J. W. S. McCullough, Chief Officer of Health, Ontario, Toronto.

Sir,—In accordance with your instructions I visited the Town of Napanee on November 28th to investigate the cause of the odours from the sewage disposal system. From time to time during the past three weeks disagreeable odours have been given off from the disposal plant and the West Street sewer. The citizens have been inclined to blame the William Davies Company for this condition.

During October and shortly before the commencement of the nuisance the Davies Company commenced the operation of a cannery and discharged their waste into the sewer at the head of West Street. An inspection of the sewage disposal plant showed that while the cannery waste was responsible for bringing the nuisance to the attention of the citizens, the disposal plant itself was in sad need of supervision. The sedimentation tanks were more than half full of sludge and only one was being operated at a time. This cut the storage to approximately one-quarter of what it was designed for. The sand beds were receiving several times the quantity of sewage they were capable of handling, with the result that they were very dirty. The effluent was malodorous and highly putrescible. These conditions alone would give rise to considerable nuisance.

In addition, however, the West Street sewer which carries the waste from the Davies cannery has not sufficient grade at the upper end for the character of waste which reaches it. This upper end has been idle for a year or more, from the time the canning company closed its doors until the William Davies Company commenced operations. It is more than probable that the sewer was partially choked before the re-opening of the factory; and when the Davies Company discharged their waste containing considerable solid matter into the sewer an obstruction occurred, the beans putrified and a vile odour was the result. Cellars were flooded with this putrifying waste, in one cellar, at least three pails of beans were collected. When the head became great enough the obstruction was overcome and the whole mass, malodorous in the extreme, was washed down to the already overloaded sewage disposal plant.

To remedy the present condition and prevent a repetition, two things will be necessary:

1. To secure the periodic (minimum twice a day) flushing of the upper end of the West Street sewer. All of the heavy waste can be kept out of the sewers by the construction of a collecting tank by the Davies Company. A periodic flushing of the sewer at frequent intervals can be secured by having the overflow from this tank operate as an automatic syphon, thus flushing the sewer at frequent intervals. The Company could also divert the water from their cooling tanks into the small stream which drains the surface water from that area. Care, however, must be taken to prevent the discharge into the stream of water carrying any waste material whatever, organic or inorganic, suspended or in solution. This would help materially to lessen the overload upon the disposal plant.

2. To put the sedimentation tanks in good working order and operate them more carefully. The sedimentation tanks should have all the sludge pumped out. In future the sludge should be pumped at frequent and regular intervals. Both tanks should be operated continuously.

(*b*) Clean the sand beds and keep them clean. To efficiently handle the quantity of sewage now discharged on the sand beds will necessitate very careful operation of the beds. They should be thoroughly cleaned immediately and operated intermittently; they should be cleaned carefully after each rest before being put into operation again. It may be found necessary to reconstruct the beds and convert them either into contact beds or sprinkling filters; the method of operation would then depend on the system adopted.

All of which is respectfully submitted.

A. V. DeLaporte,
Acting Provincial Sanitary Engineer.

December 6th, 1916.

Report Source of Ingersoll Water Supply.

Toronto, August 14th, 1916.

Dr. J. W. S. McCullough, Chief Officer of Health, Ontario, Toronto.

Sir,—Acting on your instructions I made a sanitary survey of the source of the Ingersoll water supply on July 27th in company with Dr. F. D. Canfield, the Local Medical Officer of Health, and again on August 10th in company with Mr. Hall and Mr. Gafer, the engineer and chairman, respectively, of the Ingersoll Water, Light and Power Commission.

The source of the Ingersoll water supply is secured from springs which rise in a low marsh area. The marsh contains approximately 600 acres, but the town controls only 200 acres. Cattle are pastured on the remaining 400 acres and at places have watering holes in the springs leading into the town supply. It is, therefore, not surprising that the bacterial examination of the water should show the presence of large numbers of intestinal organisms, and that at times of storms the town water supply should be coloured a deep amber hue. This condition, however, while unpleasant is not as serious as that disclosed by the presence of drains from neighbouring farms leading into the water supply. Samples of two of these gave the following results:

18°c	37°c	Number of B. Coli	Drain
210	700	100	Rice.
20	12	10	Robinson.

Robinson has a water supply in his house and disposes of the waste water in a cesspool. This is situated within 300 ft. of the collecting drain which leads into the town water supply. It constitutes an almost direct connection with the town supply.

In addition to the pollution from the source already mentioned the springs themselves as shown by bacterial examination are seriously polluted. As the source of the springs are not known it was impossible to trace the springs and locate the cause of the pollution.

A disinfection of the water supply is needed at once and chlorination should immediately be resorted to. All the drains leading into the water supply should be permanently disconnected. If possible the entire area of the marsh and its drainage area should be brought under the sanitary control of the town. The pasturing of cattle in the marsh should be prohibited, and all trespassing in the marsh on any pretext whatever should be prohibited. Proper protection should also be installed to prevent drainage from the C.P.R. tracks entering the town water supply.

BACTERIOLOGICAL RESULTS.

Location.	Sample No.	Bacterial Counts.		Fermentation B. Coli.						
		18°	37°	1/100	1/10	1cc.	5cc.	10cc.	25cc.	50cc.
Rice drain............	1	210	700	+	+	+	+	+	+	+
Head Spring..........	2	40	30	0	+	+	+	+	+	+
Hall Spring	3	4,000	3,700	0	+	+	+	+	+	+
Drain from water hole.	4	160spr.	200	0	+	+	+	+	+	+
Fitzpatrick's Well	5	160spr.	20	0	+	+	+	+	+	+
Wilson Spring	6	29	3	0	+	+	+	+	+	+
Harris.................	7	15	10	0	0	+	+	+	+	+
Robinson's Bridge.....	8	75	8	0	0	+	+	+	+	+
Robinson's Dam.......	9	20	12	0	+	+	+	+	+	+
Worth Spring.........	10	3	7spr.	0	+	0	0	+	+	+
"	11	10	0	0	0	0	+	+	+	+
Collecting Spring	12	90	10	0	0	+	+	+	+	+
" "	13	70	20	0	+	+	+	+	+	+
Clear's Well..........	14	50	20	0	0	+	+	+	+	+
Sherlock's Well.......	15	50	60	0	0	+	+	+	+	+
McIntyre Store Spring.	16	0	0	0	0	0	0	0	0	0

All of which is respectfully submitted.

A. V. DELAPORTE,

Chemist in Charge of Experimental Station.

Laboratory Reports for the Year 1916

Laboratories of the Provincial Board of Health, Toronto

Branch Laboratories at Kingston

Branch Laboratories at London (Institute of Public Health)

REPORT OF THE LABORATORIES OF THE PROVINCIAL BOARD OF HEALTH, TORONTO.

To the Chairman and Members of the Provincial Board of Health:

GENTLEMEN,—I have the honour to submit herewith a tabulated statement of the work performed in these laboratories during the year 1916. This has been a record year in the history of the laboratories, as shown by the increase in all main branches of the work. The number of specimens examined shows a total of 10,871, as follows:

Diphtheria (Swabs)			3,436
Release from Quarantine		1,116	
Positive	297		
Negative	819		
Diagnosis		2,320	
Positive	375		
Negative	1,945		
Tuberculosis (Sputum)			2,034
Positive	361		
Negative	1,673		
Typhoid (Blood)			1,267
Positive Widal	334		
Negative Widal	933		
Rabies (Brains of Animals)			92
Negri bodies present	31		
Negri bodies absent	61		
Milk			228
Fat	89		
Total solids	20		
Preservatives	16		
Count	100		
Extraneous matter	3		
Water			3,052
Bacteriological		3,004	
Chemical		48	
Liquor (for License Department):—			
Alcoholic content			403
Miscellaneous (including Coal for Public Institutions)			359
Total			10,871

It appears from our diphtheria data sheets that antitoxin is more generally used in doubtful cases than ever before, owing, no doubt, to its free distribution by the Board. This is a decided advantage, not only in the immediate saving of life but also in the prevention of secondary contact cases. Further control of the spread of diphtheria might possibly be obtained if practitioners would make more use of the laboratories in release cases.

The diagnostic work in tuberculosis, typhoid fever and rabies continues to be greatly appreciated. The methods of examination and manner of reporting were in accordance with established practice.

The number of samples of milk sent the laboratory, while greater than last year, is still much too low. The recent educational work followed by an explanatory "Circular of Laboratory Services" should have the effect of drawing the attention of local Boards of Health to the necessity for analytical control of municipal milk supplies.

The introduction of the Ontario Temperance Act meant a greater number of analyses of liquors. These results are of legal importance, especially in the enforcement of the regulations controlling the sale of beverages.

Analyses of coal, and other supplies for public institutions of the Province were continued this year with satisfactory results.

A very substantial increase in the work of the laboratories is noted in the amount of typhoid vaccine distributed. For vaccine for civilian use the following figures are recorded, 1915, 5,324 doses; 1916, 33,532 doses. On May 1st, 1916, we began the distribution of a polyvalent vaccine, carrying paratyphosus, alpha and beta, and as well typhosus. A uniform, three dose treatment was also recommended. The following are the details of shipments, of vaccine, to the various provinces for use by the Canadian Militia, in the inoculation of overseas troops at the several camps:

Ontario	269,131	doses
Manitoba	115,670	"
Quebec	321,250	"
Nova Scotia	54,650	"
British Columbia	39,000	"
Alberta	27,675	"
Total	827,376	"

The number of doses sent to the sister colony, Newfoundland, was 3,000.

The results obtained have been reported as highly satisfactory.

H. M. Lancaster,

Acting Director of Laboratories.

REPORT FROM LABORATORIES OF THE PROVINCIAL BOARD

Municipalities	Diphtheritic swabs				Tuberculous sputa		Typhoid bloods		Rabies Diagnosis			
	Release		Diagnosis							Negri Bodies		
	+	−	+	−	+	−	+	−	Animal	+	−	Animal Inoculations
Algoma—												
Blind River								1				
Bruce Mines	1	3	6	2		2						
Chapleau					2	2						
Chelmsford			1	1	1	2						
Copper Cliff												
Creighton Mines				1		4	2					
Crean Hill					1		1	3				
Cutler												
Espanola							3	1				
Goulais Bay												
Jacksonboro							2	1				
Jellicoe												
Kapuskasing												
Levack				1				1				
Magpie Mine							1					
MacLennan												
Richards Landing				1		3		2				
Schumacher												
Steelton					1	1						
Sault Ste. Marie	2	9	5	10	7	25						
South Porcupine				1				1				
Thessalon			1	1		2		1				
The Slash												
Brant—												
Brantford				4	9	34		2	dog		1	
Burford			1			3	1	2				
Ohsweken												
Paris	1	3	1	1	2	9						
Scotland						2						
St. George				1		1		2				
Bruce—												
Allanford				2	1	7						
Armow												
Chesley	1	1	2	4	2	6	1	2				
Cargill					2	2		1				
Elmwood					3	6		1	dog		1	
Hepworth						2						
Kincardine				1		1						
Lucknow						3		1				
Lorne												
Mildmay						2						
Paisley	3	2	4	8	1	5	1					
Port Elgin				3	2	23	5	4				
Ripley					1	1						
Southampton												
Tara		1		1		1		1				
Teeswater						3						
Tiverton								1				
Walkerton				1	2	1	2	2				
Carleton—												
Carp				3		4		1				
Hazeldean					1							
Kars						1		1				
Kinburn				3	1	3	1	3				
Manotick				6	1	5		1				
Metcalfe		1		1	2	5						

OF HEALTH OF ONTARIO AT TORONTO FOR YEAR 1916.

Milk: Food Content: Fats	Milk: Food Content: Total Solids	Milk: Preservatives: +	Milk: Preservatives: −	Milk: Bacteriological: Tubercle Bac.: +	Milk: Bacteriological: Tubercle Bac.: −	Milk: Bacteriological: Pus cells: +	Milk: Bacteriological: Pus cells: −	Milk: Bacteriological: Count	Milk: Extraneous matter	Waters: Chemical	Waters: Bacterial	Liquors for License Dept.	Miscellaneous Specimens	Total Specimens for year	Outfits sent out: Water	Outfits sent out: Diphtheria	Outfits sent out: T. B.	Outfits sent out: Typhoid	Outfits sent out: Total Outfits	Doses of Anti-Typhoid Vaccine sent out	Pasteur Preventive Treatment: Cases	Pasteur Preventive Treatment: Number of Injections
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REPORT FROM LABORATORIES OF THE PROVINCIAL BOARD

Municipalities	Diphtheritic swabs				Tuberculous sputa		Typhoid bloods		Rabies Diagnosis			
	Release		Diagnosis						Animal	Negri Bodies		Animal Inoculations
	+	−	+	−	+	−	+	−		+	−	
Carleton—Continued.												
North Gower					2	5		1				
Ottawa						1						
Stittsville				1				1				
Westboro												
Dufferin—												
Orangeville		1		5		2		1	cow	1		
Shelburne				1					5 dogs	2	3	
Grand Valley						2	1		dog		1	
Melancthon												
Dundas—												
Chesterville		1		2								
Iroquois												
Morrisburg				1	3	15	2	4				
South Mountain												
Durham—												
Bethany		1		2		5	2	7				
Bowmanville				4	9	23	1	3				
Blackstock		1		1		4	1					
Clarke												
Enniskillen						6		1	dog		1	
Hampton												
Millbrook				2	1	17	2	4				
Orono				4	1	7	1	4				
Port Hope				4	3	21	3	11				
Pontypool						15	1					
Selina												
Elgin—												
Aylmer												
Fingal												
Port Burwell						2						
Rodney				1		5			dog	1		
St. Thomas									dog	1		
Straffordville						3						
Springfield												
Southwold St.												
West Lorne												
Essex—												
Amherstburg						1						
Belle River												
Comber					2	3	1	1				
Essex				2	2	19						
Ford City	8	3	2	1	1	4		2				
Harrow												
Kingsville			1	2		5		1				
Leamington					2	4						
Loiselleville							1					
McGregor						1						
S. Woodslee												
Sandwich	2	9	8	90			1	1				
Tecumseh				3	1	2	1	3				
Walkerville	1		5	6	1	3	1					
Windsor	108	270	58	414	6	42	13	16	dog		1	
Frontenac—												
Ardoch												
Burridge												
Cataraqui												
Kingston												

OF HEALTH OF ONTARIO AT TORONTO FOR YEAR 1916.—*Continued.*

Milk: Food Content: Fats	Milk: Food Content: Total Solids	Milk: Preservatives: +	Milk: Preservatives: —	Milk: Bacteriological: Tubercle Bac.: +	Milk: Bacteriological: Tubercle Bac.: —	Milk: Bacteriological: Pus cells: +	Milk: Bacteriological: Pus cells: —	Milk: Bacteriological: Count	Milk: Extraneous matter	Waters: Chemical	Waters: Bacterial	Liquors for License Dept.	Miscellaneous Specimens	Total Specimens for year	Outfits sent out: Water	Outfits sent out: Diphtheria	Outfits sent out: T. B.	Outfits sent out: Typhoid	Outfits sent out: Total Outfits	Doses of Anti-Typhoid Vaccine sent out	Pasteur Preventive Treatment: Cases	Pasteur Preventive Treatment: Number of Injections
																36	30	36	102	12		
																				33		
															2				2			
															9							
															4				4	6	1	21
											1						2	2	4	23		
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REPORT FROM LABORATORIES OF THE PROVINCIAL BOARD

Municipalities	Diphtheritic swabs				Tuberculous sputa		Typhoid bloods		Rabies Diagnosis			
	Release		Diagnosis						Animal	Negri Bodies		Animal Inoculations
	+	−	+	−	+	−	+	−		+	−	
Frontenac—Continued.												
Long Lake												
Sharbot Lake					1							
Vernon												
Glengarry—												
Alexandria					6	12	1	4				
Apple Hill				1								
Dunvegan				1	2			1				
Dalhousie Mills					2	5	2					
Maxville				2	3	3						
Martintown			1		1	1		2				
Williamstown				1								
Grenville—												
Cardinal		3	2									
Kemptville			2		4	10	2	2				
Prescott				1	3	5						
Merrickville												
Spencerville						2						
Grey—												
Annan		7		2	1	8						
Ayton						1						
Chatsworth			1					1				
Clarksburg						3						
Dundalk			2	3		10						
Durham				1	3	7		2				
Desboro		1	1	4		2		2				
Dornoch								2				
Dromore												
Flesherton					1							
Hanover						1	1	1				
Heathcote						1						
Holstein				1	1	4						
Markdale			1	4	2	7	2	4				
Maxwell	1		1	1		1		1				
Meaford					2	6		2				
Neustadt				2								
Owen Sound	3	16	11	41	3	17	2	10				
Priceville					1				dog		1	
Rocklyn					2	3						
Shallow Lake						1						
Thornbury						1						
Haldimand—												
Caledonia				1	1	3		1				
Canfield												
Cayuga						2	1					
Dunnville				1	1	8	2	17				
Fisherville												
Hagersville						2	2	1				
Jarvis				1	2	5		3				
Manticoke												
Halton—												
Acton												
Burlington		14	2	2			1		3 dogs		3	
Bronte												
Campbellville												
Georgetown	8	14	2	17		9		5				
Freeman									dog		1	

OF HEALTH OF ONTARIO AT TORONTO FOR YEAR 1916.—*Continued.*

Milk										Waters					Outfits sent out						Pasteur Preventive Treatment	
Food Content		Preservatives		Bacteriological																		
				Tubercle Bac.		Pus cells																
Fats	Total Solids	+	−	+	−	+	−	Count	Extraneous matter	Chemical	Bacterial	Liquors for License Dept.	Miscellaneous Specimens	Total Specimens for year	Water	Diphtheria	T. B.	Typhoid	Total Outfits	Doses of Anti-Typhoid Vaccine sent out	Cases	Number of Injections
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	12	...	15	...	27	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	7	...	7	550	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	10	...	10	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	1	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	6	10	...	16	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	12	12	36	10	70	10	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	12	...	...	...	12	6	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	36	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	6	10	16	10	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1	1	3	10	...	...
...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	1	...	6	5	12	6	...	...
...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	2	1	1	1	5	12	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	24	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	48	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	10	...	10	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	1	...	1	8	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	2	2	6	...	...	...
...	...	...	...	...	...	...	...	...	...	...	6	...	...	...	12	2	2	2	18	...	1	21
...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	25	...	1	...	24	10	13	...	47	136	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	12	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	2	1	4	36	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	6	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	50	...	...
...	...	...	...	...	...	...	...	...	...	...	9	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	6	...	...	...	...	...	6	6	...	...	...
...	...	...	...	...	...	...	...	...	...	...	5	...	...	...	6	6	25	18	55	26	...	...
...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	3	...	...	...	6	2	2	2	12	36	...	...
...	...	...	...	...	...	...	...	...	...	...	19	...	...	...	12	...	10	...	22	18	...	...
...	...	...	...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	6	...	...	...	8	...	...	...	8	...	...	...
...	...	...	...	...	...	...	...	...	...	...	70	...	...	...	99	...	...	...	99	...	1	21
...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	2	...	...	...	2	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	6	...	...
...	...	...	...	...	...	...	...	...	...	...	7	...	...	...	12	36	12	...	60	12	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

REPORT FROM LABORATORIES OF THE PROVINCIAL BOARD

Municipalities	Diphtheritic swabs				Tuberculous sputa		Typhoid bloods		Rabies Diagnosis			
	Release		Diagnosis						Animal	Negri Bodies		Animal Inoculations
	+	—	+	—	+	—	+	—		+	—	
Halton—Continued.												
Limehouse												
Milton				1	1	4			2 dogs		2	
Norval												
Oakville				4		1	2	14				
Palermo						1						
Sheridan												
Haliburton—												
Deer Lake								1				
Haliburton								1				
Lowbanks												
Minden												
Hastings—												
Belleville			2	11	6	5	14	180				
Bancroft												
Coe Hill												
Eldorado			1	2			2	1				
Deseronto												
Frankford					2	2		1				
Foxboro					2	2		2				
Madoc				2	2	4	2					
Marmora				4	2	6		2				
Maynooth					1	1						
Mill Bridge												
Springbrook						1	2	1				
Stirling												
Steenburg												
Sulphide												
Trenton	2		2	2	1	2	6	3				
Tweed												
Huron—												
Blyth		3		3		4			dog		1	
Brucefield				2		1						
Brussels				1		2	2	3				
Bluevale												
Crediton	1	1		2				2				
Ethel						1	2	5	Pig		1	
Exeter					1	2						
Goderich	1	1	1			1	4	4	dog		1	
Gorrie						1						
Fordwich				1								
Hensall						1						
Kintail												
Kippen												
Seaforth						1	1	2				
Wingham	6	3	12	13		6			dog		1	
Wroxeter												
Kirkton						1						
Kent—												
Bothwell					1							
Blenheim					3	1	1					
Chatham			1	2	5	33	3	12				
Dresden		3			1	5						
Duart					1	2						
Merlin			1	2	3	9						
Ridgetown	1	1	3			3						
Thamesville					1	5						

OF HEALTH OF ONTARIO AT TORONTO FOR YEAR 1916.—*Continued.*

Milk: Food Content: Fats	Milk: Food Content: Total Solids	Milk: Preservatives: +	Milk: Preservatives: —	Milk: Bacteriological: Tubercle Bac. +	Milk: Bacteriological: Tubercle Bac. —	Milk: Bacteriological: Pus cells +	Milk: Bacteriological: Pus cells —	Milk: Bacteriological: Count	Milk: Extraneous matter	Waters: Chemical	Waters: Bacterial	Liquors for License Dept.	Miscellaneous Specimens	Total Specimens for year	Outfits sent out: Water	Outfits sent out: Diphtheria	Outfits sent out: T. B.	Outfits sent out: Typhoid	Outfits sent out: Total Outfits	Doses of Anti-Typhoid Vaccine sent out	Pasteur Preventive Treatment: Cases	Pasteur Preventive Treatment: Number of Injections
											1											
											3				6				6			
											3				2				2			
1										1	36				24			12	36	10		
											1											
																				4		
																24			24			
										1	25				69		61	133	263	80		
																				6		
																				8		
																				4		
											6											
																	10		10			
											3				1	6	6	6	19	24		
											26								16			
																				38		
																				12		
																6	5	6	17	16		
																				48		
											2											
											1				1				1			
											16				19	36	5	6	66	38		
															6			6		35		
															1		5		6			
																		1	1			
																				2		
													2		6	24	15		45			
											3				6			12	18	12		
																	25		25	6		
												4				12	25	24	61	20		
															1				1	2		
															2				2			
											1											
																12			12	36		
											7				1	2			3	6		
											1		1									
																	5		5			
																10			10			
											38		1		6	12	15	18	51			
																	10		10	12		
																2	2	2	6			
																12	10	12	34			
											6				3	14	2	2	21	10		
																	15		15	12		

REPORT FROM LABORATORIES OF THE PROVINCIAL BOARD

Municipalities	Diphtheritic swabs				Tuberculous sputa		Typhoid bloods		Rabies Diagnosis			
	Release		Diagnosis						Animal	Negri Bodies		Animal Inoculations
	+	—	+	—	+	—	+	—		+	—	
Kent—Continued.												
Tilbury				1	1							
Tupperville												
Wallaceburg					2	5	1	3				
Kenora—												
Dryden						1						
Keewatin						5						
Kenora												
Lanark—												
Almonte	1	5	4	4	1	2	1					
Carleton Place				1	1	1						
Clayton						1						
Lanark						1	5	2				
Maberley												
Middleville					1	1						
Perth					1	1	3	1				
Pakenham	1	1	1		1							
Smith's Falls					1	3	2					
Lambton—												
Alvinston					1	2						
Brigden					1							
Camlachie												
Corunna						1						
Florence	1	3			2	2						
Forest						2						
Petrolia	1		2	10	1	6						
Pt. Edmund												
Pt. Lambton												
Sarnia			2	7	1	4						
Sombra					1	1	1					
Watford				1		3						
Wilkesport					2	1						
Wyoming					1			1				
Oil Springs												
Thedford				1								
Leeds—												
Athens												
Brockville	3	2			1	9	1	9				
Denbigh												
Elgin												
Lansdowne												
Malloytown				4		1		3				
Napanee												
Newboro												
Plum Hollow												
Tamworth												
Yarker												
Lincoln—												
Beamsville				1		8	1	6	2 dogs	1	1	
Grimsby				3		3	2	3	2 dogs		2	
Jordan				2			5	3				
Merritton												
Niagara-on-the-Lake								4				
St. Catharines		7	2	6	3	24	7	6				
St. David's						1						

OF HEALTH OF ONTARIO AT TORONTO FOR YEAR 1916.—*Continued.*

Milk										Waters		Liquors for License Dept.	Miscellaneous Specimens	Total Specimens for year	Outfits sent out					Doses of Anti-Typhoid Vaccine sent out	Pasteur Preventive Treatment	
Food Content		Preservatives		Bacteriological					Extraneous matter													
				Tubercle Bac.		Pus cells		Count														
Fats	Total Solids	+	−	+	−	+	−			Chemical	Bacterial				Water	Diphtheria	T. B.	Typhoid	Total Outfits		Cases	Number of Injections
											1											
											28				25	2	17	2	46			
																				74		
																	2					
											1									100		
																4			4	24		
											2				12				12	104		
												1										
															4				4	64		
																1			1	12		
											19				30	2	4		36	86		
																12	15		27			
4											209				225		10	12	247	5223		
																				2		
																				20		
																12			12			
											1											
																24			24			
											3				1	2	2	2	7			
															1	30	10		41			
																				6		
											1											
										7	18	3			18	12	10		40	2694		
											1					2	2		4	9		
											3									48		
																2	1	2	5	18		
																				24		
																				62		
											1		22		1	24	24	24	73	108		
																				24		
																12	10	12	34	10		
																60			60	10		
																18			18	42		
																				10		
																				12		
													1			12			12	24		
																12			12	12		
																				54		
											5				8		10		18	1		
											1		2			12	10	12	34	48	2	42
																2	2	2	6			
																				12		
											7				1				1			
											105				99	7	42	4	152	147		
													1									

REPORT FROM LABORATORIES OF THE PROVINCIAL BOARD

Municipalities	Diphtheritic swabs: Release +	Diphtheritic swabs: Release −	Diphtheritic swabs: Diagnosis +	Diphtheritic swabs: Diagnosis −	Tuberculous sputa +	Tuberculous sputa −	Typhoid bloods +	Typhoid bloods −	Rabies Diagnosis: Animal	Rabies Diagnosis: Negri Bodies +	Rabies Diagnosis: Negri Bodies −	Rabies Diagnosis: Animal Inoculations
Lincoln—Continued.												
Smithville						1						
Port Dalhousie						2		2				
Welland Port				1	1	1	2	3				
Manitoulin—												
Gore Bay												
Little Current						1		2				
Mindemoya			1									
Middlesex—												
Ailsa Craig			1		1	6		1				
Glencoe												
Grafton						1						
Lobo												
London												
Melbourne						1						
Mt. Brydges					1	1						
Strathroy					1	2						
Southwold St.												
Parkhill												
Thorndale									dog		1	
Muskoka—												
Balla							1					
Bracebridge				2	3	4	1	1				
Gravenhurst			1	1	1	1						
Glenmount												
Huntsville		2	2	7	3	12		3				
Pt. Carling						1						
Pt. Cockburn												
Rosseau				1		3	4	1				
Severn Bridge				1	2	4		3				
Nipissing—												
Cache Bay												
Gowganda						1						
Kirkland Lake							1					
Mattawa						2						
Matheson												
North Bay	4	12	13	22	1	8	1	1				
Sturgeon Falls			1	1	1	6						
Swastika												
Smooth Rock Falls								2				
Norfolk—												
Delhi				2		5	2	1				
Langton		2										
Pt. Dover		1						2				
Pt. Rowan				2		6		2				
Simcoe				6	3	8	1	5				
Victoria												
Waterford						3						
Walkington												
Lynedock						2						
Northumberland—												
Brighton					3	4	3					
Campbellford						1	1					
Castleton						2	1	2				
Cobourg			1	7	7	13	4	16				2
Colborne				1	1	6	4	5				

OF HEALTH OF ONTARIO AT TORONTO FOR YEAR 1916.—*Continued.*

Milk: Food Content		Milk: Preservatives		Milk: Bacteriological						Waters		Liquors for License Dept.	Miscellaneous Specimens	Total Specimens for year	Outfits sent out					Doses of Anti-Typhoid Vaccine sent out	Pasteur Preventive Treatment	
				Tubercle Bac.		Pus cells																
Fats	Total Solids	+	—	+	—	+	—	Count	Extraneous matter	Chemical	Bacterial				Water	Diphtheria	T. B.	Typhoid	Total Outfits		Cases	Number of Injections
																2	2	2	6			
																	10		10			
												1								12		
											2						10		10	12		
											3						15		15			
																				28		
																6			6			
										2	7		6		12				12			
											3											
																	2		2			
											3				2	2	12	14	30			
																					1	21
																12			12			
											4				6				6	48		
											2					6	5	6	17			
											14				18				18	4		
											1				1				1			
2									1							14	10	12	36	6		
																6			6			
											1											
											2					2	4	2	8	60		
											1											
																				12		
																6	5	6	17			
											57				68	18	15	6	107			
															30	24	17	20	91	24		
											25		6							6		
													1		12				12			
											4											
											5									6		
																1	6	1	8			
																6	5	6	17			
											2											
															1	2	2	8	13			
5								5			2	39	2			6	15	6	27	24		
											1					36	35	36	107	8		
											1				1				1			
															3		1		4	18		
																				8		
											1				6	2	17	3	28	20		
											1											
																				6		
3	1							3			2				31	12	46	24	113	130		
											3				12	2	3	4	21	39		

REPORT FROM LABORATORIES OF THE PROVINCIAL BOARD

Municipalities	Diphtheritic swabs				Tuberculous sputa		Typhoid bloods		Rabies Diagnosis			
	Release		Diagnosis						Animal	Negri Bodies		Animal Inoculations
	+	−	+	−	+	−	+	−		+	−	
Northumberland—												
Grafton				1		1						
Warkworth						2		3				
Wooler						5		1				
Hastings			1	2		2						
Ontario—												
Atherley												
Beaverton				1		1		3				
Brooklyn												
Brougham						1						
Cannington				2		1	1	2				
Cedarvale												
Claremont		1										
Columbus												
Oshawa				7	1	9		1				
Pickering												
Pt. Perry					1	4	1	4				
Seagrave						3		1				
Saintfield						1						
Sunderland					1	2		1				
Uxbridge					2	12		3				
Whitby					4	4	1	1	dog		1	
Zephyr				5								
Oxford—												
Beachville							1	1				
Drumbo			1		1	2						
Embro							2	1				
Ingersoll			1	4	5	28	1	9	dog		1	
Mt. Elgin												
Norwich				1				6	dog		1	
Otterville						7			dog, pig	1	1	
Plattsville				1		6	1	1				
Princeton								2				
Lakeside												
Oxford Centre												
Tavistock				2		3		1				
Thamesford												
Tillsonburg				1	2	9		4	dog	1		
Woodstock				2	5	28	9	14				
Parry Sound—												
Ardbeg								1				
Burk's Falls				9		10	1	3				
Byng Inlet				2		2	1	8				
Calendar								1				
Depot Harbor				2								
Elmsdale												
Kearney		2		6		1						
Maple Lake St.												
Magnetawan					1							
McKellar						2	4	1				
Nipissing												
Nobel												
Parry Sound	3	6	4	19	2	11	11	29				
Powassan				2	2	9	2	9				
Ravensworth												
South River						4						
Sprucedale					1	13		1				
Sundridge				1		6	1	4				

OF HEALTH OF ONTARIO AT TORONTO FOR YEAR 1916.—*Continued.*

Milk: Food Content: Fats	Milk: Food Content: Total Solids	Milk: Preservatives +	Milk: Preservatives −	Milk: Bacteriological: Tubercle Bac. +	Milk: Bacteriological: Tubercle Bac. −	Milk: Bacteriological: Pus cells +	Milk: Bacteriological: Pus cells −	Milk: Bacteriological: Count	Milk: Extraneous matter	Waters: Chemical	Waters: Bacterial	Liquors for License Dept.	Miscellaneous Specimens	Total Specimens for year	Outfits sent out: Water	Outfits sent out: Diphtheria	Outfits sent out: T. B.	Outfits sent out: Typhoid	Outfits sent out: Total Outfits	Doses of Anti-Typhoid Vaccine sent out	Pasteur Preventive Treatment: Cases	Pasteur Preventive Treatment: Number of Injections
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	6	12	10	12	40	...	...	...
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...	...	...	...	...	...	...	...	...	...	...	2	...	...	...	...	2	2	2	6	...	...	...
...	...	...	...	...	...	...	...	...	...	...	3	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	2	...	...	...	...	6	5	18	29	8	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	21
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
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...	...	...	...	...	...	...	...	...	1	...	27	...	...	...	38	2	12	2	54	273	1	21
...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...
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...	...	...	...	...	...	...	...	...	...	...	10	...	33	...	6	6	5	6	23	...	...	...
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...	...	...	...	...	...	...	...	...	...	...	3	...	...	...	3	...	...	...	3	18	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	20	6	25	12	63	2	1	21
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	12	...	...
...	...	...	...	...	...	...	...	...	...	2	2	...	1	...	...	...	...	24	27	...	...	...
...	...	...	...	...	...	...	...	...	...	...	10	...	...	...	...	...	12	36	48	12	1	21
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	6	10	6	22	16	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	12	12	12	...	...
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...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	8	...	25	...	33	...	...	...
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REPORT FROM LABORATORIES OF THE PROVINCIAL BOARD

Municipalities	Diphtheritic swabs				Tuberculous sputa		Typhoid bloods		Rabies Diagnosis			
	Release		Diagnosis						Animal	Negri Bodies		Animal Inoculations
	+	—	+	—	+	—	+	—		+	—	
Peel—												
Alton				1		2	2	1				
Bolton				2		4			dog	1		
Brampton	1		2	2	1	7						
Caledon				2		1	1	4	{ dog putrid { cat	1		
Caledon E.								1				
Clarkson				1		1	1					
Dixie												
Erindale												
Lorne Park												
Mono Road						1	1	1	cat		1	
Mono Mills						1						
Malton												
Palgrave				3		3		2				
Pt. Credit	1	2	2	3		2	3	2				
Streetsville						1		2				
Perth—												
Atwood				1		1	3	2				
Dublin								1				
Kirkton						3		1				
Listowel	4	1	1	5	3	6	2	11				
Milverton												
Mitchell			2	1	1	2		1				
Monkton						3		2				
St. Mary's				1	1	3	2		2 dogs	1	1	
Sebringville												
Shakespeare					1							
Stratford	3	9	2	6	1	19		6				
Millbank						3						
Peterboro—												
Bailieboro				1		2	1	1				
Havelock				1	1	2		1	dog		1	
Keene						2	1	1				
Lakefield						1	1	2				
Oak Orchard												
Peterboro	52	92	42	164	6	24	8	14				
Prescott												
Alfred					2	3						
Chute à Blondeau						1	5	2				
Fornier		1	1									
Hawkesbury						2		3				
Lefaivre						2						
Plantagenet						1						
Riceville	1			3								
St. Eugene												
St. Isidore de Prescott					1	1						
Prince Edward—												
Bloomfield	1	2	2	1				1				
Consecon				1								
Demorestville												
Picton		2	1	4	1	10	1					
Wellington												
Rainy River—												
Emo												
Ft. Frances			1	1	1	3	1					
Rainy River						2						
Sioux Lookout						1						

OF HEALTH OF ONTARIO AT TORONTO FOR YEAR 1916.—*Concluded.*

Milk: Food Content: Fats	Milk: Food Content: Total Solids	Milk: Preservatives: +	Milk: Preservatives: —	Milk: Bacteriological: Tubercle Bac.: +	Milk: Bacteriological: Tubercle Bac.: —	Milk: Bacteriological: Pus cells: +	Milk: Bacteriological: Pus cells: —	Milk: Bacteriological: Count	Milk: Extraneous matter	Waters: Chemical	Waters: Bacterial	Liquors for License Dept.	Miscellaneous Specimens	Total Specimens for year	Outfits sent out: Water	Outfits sent out: Diphtheria	Outfits sent out: T. B.	Outfits sent out: Typhoid	Outfits sent out: Total Outfits	Doses of Anti-Typhoid Vaccine sent out	Pasteur Preventive Treatment: Cases	Pasteur Preventive Treatment: Number of Injections
																2	12	2	16			
											5				12	6	5	6	29	12		
											1		1									
											1					2	2	2	6		2	42
															2	1	1	1	5	18		
											5				15	12			27			
											2				1				1			
											1											
											1											
															1				1			
											2									2		
															3				3			
											5		1				10	12	22	16		
											14					12	12		24	12		
													1			6	10	6	22			
											2	1			15		4		19			
																				46		
											1									20		
																2	2	2	6	9		
											6				4	6	5	6	21	6	1	21
											1				1				1			
											1				2				2	12		
											29	4	2		36	17	15		68	24		
											2									48		
											16				18		3		21	10		
																	6		6			
											1				1				1			
											22	2	8		31	434	12	8	485	3		
											6				10	12	10	18	50	6		
																		18	18	16		
																5	8	5	18			
																12	10		22			
																				24		
																				6		
											1				2				2	4		
																				4		
25								25			3					12	10	12	34	21		
											1											
																				250		
											2				6				6			
																2	3	2	7			

REPORT FROM LABORATORIES OF THE PROVINCIAL BOARD

Municipalities	Diphtheritic swabs				Tuberculous sputa		Typhoid bloods		Rabies Diagnosis			
	Release		Diagnosis									
	+	—	+	—	+	—	+	—	Animal	Negri Bodies +	Negri Bodies —	Animal Inoculations
Renfrew—												
Arnprior												
Cobden												
Clontarf												
Craigmount					1							
Eganville					1	14		2				
Douglas												
Kartum												
Pembroke												
Petawawa												
Renfrew			3	7	3	16	4	6				
Westmeath			1		1							
Russell—												
Bourget	2	11	5	4	3	3		3				
Clarence Creek				2	1		1	1				
Castleman												
Navan		1	7	18	1	2		1				
Rockland		3		3	1	1	1					
Russell						6						
Simcoe—												
Allandale						1						
Angus				1								
Alliston				1		1						
Barrie				9	4	18	1	9				
Beeton		1	1	7								
Bond Head				1				2				
Bradford					1	2		1				
Camp Borden												
Collingwood		1	5	6	4	12						
Coldwater				5		3	1	2				
Cookstown				2	4	9		1				
Creemore			1	1		3		4				
Churchill						3						
Edgar			1	3				1				
Elmvale						6		2				
Everett						1						
Lisle												
Midland			2		1	2	1	1				
Orillia	8	17	17	130	5	118	9	21				
Penetang	1	1	6	5	1	29	3	11	dog		1	
Phelpston				4		9		2				
Pt. McNicoll				5		2						
Stayner			1	1				2				
Stroud						1						
Hillsdale												
Thornton				2		3			dog		1	
Tottenham					1	1						
Victoria Harbor			1	3	2	6	2	8				
Waubaushene				1		1						
Randolph												
Stormont—												
Aultsville				1		1						
Cornwall			3	1		1						
Crysler		3	1		1	1	1	1				
Farran's Point												
Mille Roches								1				
Newington												
Osnabruck						4						

OF HEALTH OF ONTARIO AT TORONTO FOR YEAR 1916.—*Continued.*

Milk: Food Content: Fats	Milk: Food Content: Total Solids	Milk: Preservatives: +	Milk: Preservatives: —	Milk: Bacteriological: Tubercle Bac.: +	Milk: Bacteriological: Tubercle Bac.: —	Milk: Bacteriological: Pus cells: +	Milk: Bacteriological: Pus cells: —	Milk: Bacteriological: Count	Milk: Extraneous matter	Waters: Chemical	Waters: Bacterial	Liquors for License Dept.	Miscellaneous Specimens	Total Specimens for year	Outfits sent out: Water	Outfits sent out: Diphtheria	Outfits sent out: T. B.	Outfits sent out: Typhoid	Outfits sent out: Total Outfits	Doses of Anti-Typhoid Vaccine sent out	Pasteur Preventive Treatment: Cases	Pasteur Preventive Treatment: Number of Injections
...	...	...	...	...	...	...	...	...	...	...	2	...	1	...	...	...	...	...	...	10	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	20	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	6	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	2	2	6	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	15	...	17	36	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	6	5	6	17	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	12	...	...
...	...	...	...	...	...	...	...	...	...	...	59	...	...	...	120	...	...	...	120	36	...	...
...	...	...	...	...	...	...	...	...	...	5	...	...	...	...	42	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	146	120	73	338	12	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	24	...	...
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...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	24	...	...	24	...	...	...
...	...	...	...	...	...	...	...	...	...	...	3	...	...	...	...	...	...	...	...	...	...	...
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...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	2	2	6	...	...	...
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...	...	...	...	...	...	...	...	...	...	...	2	...	...	...	...	12	10	12	34	24	...	...
...	...	...	...	...	...	...	...	...	...	...	5	...	...	...	12	...	...	...	12	...	1	21
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
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24	11	...	11	...	...	...	...	24	...	...	14	...	...	...	8	24	25	...	57	50	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	87	...	...
...	...	...	...	...	...	...	...	...	...	...	9	...	...	...	7	...	15	...	22	...	...	...
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...	...	...	...	...	...	...	...	...	...	...	...	...	6	...	...	...	...	...	...	24	...	...
1	...	...	...	...	...	...	...	35	...	...	265	1	42	...	322	102	3	14	441	36	...	...
...	...	...	...	...	...	...	...	...	...	...	6	...	10	...	10	26	19	10	65	32	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1	1	3	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	...	...	2	12	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	20	...	...
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...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	108	5	6	119	40	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	8	7	8	23	4	...	...
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...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	10	...	10	10	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

REPORT FROM LABORATORIES OF THE PROVINCIAL BOARD

Municipalities	Diphtheritic swabs				Tuberculous sputa		Typhoid bloods		Rabies Diagnosis			
	Release		Diagnosis						Animal	Negri Bodies		Animal Inoculations
	+	—	+	—	+	—	+	—		+	—	
Sudbury—												
Chapleau						1						
Coniston				2		3	1	1				
Massey												
Sudbury			2	2	9	25	1	1				
Warren												
Webbwood			2	1		1		2				
Temiskaming—												
Charlton												
Cobalt			1		3	2						
Cochrane					1	8	8	6				
Englehart												
Haileybury	1			1	1	7						
Hilliardton												
Iroquois Falls			1	2		2						
Matheson												
New Liskeard		2		7	4	17		7				
Timmins							5	7				
Whitney								2				
Thunder Bay—												
Ft. William						1		1	dog		1	
Pt. Arthur				1	1	9		4	dog		1	
Silver Mountain												
Victoria—												
Bobcaygeon						4						
Kinmount				1								
Little Britain				4	1	5						
Lindsay		2		2	6	15	6	7				
Oakwood			1	2		1						
Omemee		2	1	7		4						
Victoria Road			2	2								
Woodville						1						
Waterloo—												
Ayr		1	3	10		7		3				
Baden						2						
Elmira				3	1	10	3	9				
Galt			2	20	10	17	2	11	dog	1		
Hespeler			1	1		1						
Kitchener	26	140	6	19	11	27	1	3	dog		1	
Lynwood					1	2						
New Dundee				5		1						
New Hamburg	1			2	1	3	2	12				
Petersburg												
Preston					3	5		1				
Waterloo	7	25	7	38	5	8						
Wellesley						5	1					
Winterbourne												
Welland—												
Bridgeburg				1				1				
Fenwick						2		1				
Fonthill				2	1		9	3				
Marshville				2				1				
Niagara Falls				1		4		2	2 dogs	1	1	
Pt. Colborne			2	2	1	4	1					
Pt. Robinson				2		2	1	1				

OF HEALTH OF ONTARIO AT TORONTO FOR YEAR 1916.—*Continued.*

Milk										Waters		Liquors for License Dept.	Miscellaneous Specimens	Total Specimens for year	Outfits sent out					Doses of Anti-Typhoid Vaccine sent out	Pasteur Preventive Treatment	
Food Content		Preservatives		Bacteriological					Extraneous matter													
				Tubercle Bac.		Pus cells		Count														
Fats	Total Solids	+	−	+	−	+	−			Chemical	Bacterial				Water	Diphtheria	T. B.	Typhoid	Total Outfits		Cases	Number of Injections
											8					2	2	2	6			
											1		2							6		
											198	14										
															168		48		216	180		
																				20		
											8											
										3	34	2			40				40	28		
											69	2			117	1	1	1	120	2500		
											2											
											8	4	1		87	40	2	2	131	18		
																				72		
											56											
											1				1				1			
											6		2				25		25	50		
								1	1		22				24			12	36	2450		
																				12		
											2									72		
											2					2	2	2	6	64		
											3											
											2											
											1				29	1	65	96	191	120		
										2	32									48		
											1					12	5		17			
																		6	6			
																2	2	2	6	12		
											1											
																12	10		22	38		
											8				8				8	24		
											15				30	10	32	10	82	50		
											12				6				6	16		
										10	50	19	2		72		60	6	138	6		
																	10		10			
											1				3				3	30		
											2											
5								5			1					3	3	3	9			
										3	1				25	48			73	12		
											1											
																				18		
											1									4		
													1			4	10		14	37		
											30				36				36	21		
											4									84		

REPORT FROM LABORATORIES OF THE PROVINCIAL BOARD

Municipalities	Diphtheritic swabs				Tuberculous sputa		Typhoid bloods		Rabies Diagnosis			
	Release		Diagnosis						Animal	Negri Bodies		Animal Inoculations
	+	—	+	—	+	—	+	—		+	—	
Welland—Continued.												
Ridgeville												
Ridgeway					1							
Stanford												
Stevensville					1	4						
Thorold		2				1		1				
Welland		5	6	6		4	2	1	cow	1		
Wellington—												
Alma			2		1	6		1			1	
Arthur			3	1	2				dog	1		
Clifford						2		3				
Drayton				2		3	1	3				
Erin				2	1	2		1				
Elora				1	1	4		2				
Fergus					2	4						
Glen Allan				1	1	9		4				
Guelph		1		3		12	1	6	dog		1	
Harriston					2			1				
Hillsburg				1		1		1	dog	1		
Moorefield						4						
Morriston		1	1		1							
Mt. Forest				1		6		2				
Palmerston				1		1		2				
Puslinch												
Rockwood		1	1	1								
Wallenstein												
Wentworth—												
Ancaster		1		4		1						
Bartonville												
Binbrook				1		1						
Dundas		1	1	7	1	8		1				
Freelton				6		3						
Glanford												
Hamilton		1	2	2	1				3 dogs		3	
Lynden			1	1		1						
Mt. Hope								1				
Winona												
York—												
Armour Heights												
Agincourt				4								
Aurora					1	1						
Birch Cliff												
Danforth												
Etobicoke												
Ellesmere												
Fairbank										1		
Highland Creek												
Islington						3						
Kleinburg									2 dogs	2		
Keswick												
King			1	2		3			2 dogs		2	
Leaside												
Long Branch									dog	1		
Lansing												

OF HEALTH OF ONTARIO AT TORONTO FOR YEAR 1916.—*Continued.*

Milk										Waters		Liquors for License Dept.	Miscellaneous Specimens	Total Specimens for year	Outfits sent out					Doses of Anti-Typhoid Vaccine sent out	Pasteur Preventive Treatment	
Food Content		Preservatives		Bacteriological					Extraneous matter													
				Tubercle Bac.		Pus cells																
Fats	Total Solids	+	−	+	−	+	−	Count		Chemical	Bacterial				Water	Diphtheria	T. B.	Typhoid	Total Outfits		Cases	Number of Injections
																36	30	36	102	86		
											3						1		1			
											1											
																				45		
											17				25				25			
											18	2			12	1	1		14	160		
											8											
																				4		
											5						5	6	11	28		
											3						5		5			
											2				4	12	10	12	38	12		
																				12		
											1				12				12	18		
										3	138		24		248	26	2	2	278	50		
											1		6			6	5	6	17			
											1		1									
																3	2	2	7			
											1		1			2	12	2	16			
																2	2	2	6	21		
																6	5		11			
											3				3				3			
												3										
															14	2	2		18			
																12	10		22			
											3					13	10		23	9		
											1											
																				10		
3			3								11		10							177	1	21
																1			1			
																					1	21
										1	1											
											2				6				6	18		
													1		1							
											2											
1								1							1				1			
											1											
8	8																					
																					1	21
											1											
											1											
															1				1			
																10	9	10	29	24		
										1	4		1									
										1	1											
											2											

REPORT FROM LABORATORIES OF THE PROVINCIAL BOARD

Municipalities	Diphtheritic swabs: Release +	Diphtheritic swabs: Release —	Diphtheritic swabs: Diagnosis +	Diphtheritic swabs: Diagnosis —	Tuberculous sputa +	Tuberculous sputa —	Typhoid bloods +	Typhoid bloods —	Rabies Diagnosis: Animal	Rabies Diagnosis: Negri Bodies +	Rabies Diagnosis: Negri Bodies —	Rabies Diagnosis: Animal Inoculations
York—Continued.												
Locust Hill	....	....	....	....	....	....	....	....	......	......	......	......
Maple	....	....	....	....	....	....	....	....	dog	......	1	......
Markham	....	....	....	2	....	2	....	....	......	......	......	......
Mimico	7	52	20	362	1	10	....	5	......	......	......	......
Mt. Albert	....	....	....	2	....	9	....	1	......	......	......	......
Mt. Dennis	....	....	1	2	....	....	....	....	......	......	......	......
New Toronto	....	....	....	....	....	....	....	....	......	......	......	......
Newmarket	1	....	4	....	....	5	....	....	......	......	......	......
Nobleton	....	....	....	....	....	....	....	....	dog	......	1	......
Oakwood	1	....	....	....	....	....	....	....	......	......	......	......
Pefferlaw	....	....	....	2	....	....	....	....	......	......	......	......
Queensville	....	....	....	....	....	....	....	2	......	......	......	......
Richmond Hill	2	1	2	1	1	3	....	....	......	......	......	......
Scarboro	....	....	....	....	....	....	....	....	dog	......	1	......
Schomberg	....	....	....	2	....	....	....	....	pig	......	1	......
Stouffville	....	2	1	....	2	....	....	....	......	......	......	......
Sutton West	....	....	....	....	1	....	....	2	......	......	......	......
Swansea	....	....	....	....	....	4	....	....	......	......	......	......
Todmorden	....	....	....	....	....	....	....	....	......	......	......	......
Thornhill	....	....	....	....	....	....	....	1	......	......	......	......
Toronto	13	14	3	34	3	22	31	51	25 dogs 1 cat	12	13	13 1
Unionville	....	....	....	....	....	1	....	....	......	......	......	......
Weston	....	1	3	16	....	5	....	9	......	......	......	......
Willowdale	....	....	....	....	....	....	....	....	......	......	......	......
Woodbridge	....	....	....	....	....	....	....	1	......	......	......	......
York Mills	....	....	....	....	....	....	....	....	......	......	......	......

OF HEALTH OF ONTARIO AT TORONTO FOR YEAR 1916.—*Concluded.*

Milk										Waters					Outfits sent out						Pasteur Preventive Treatment	
Food Content		Preservatives		Bacteriological																		
				Tubercle Bac.		Pus cells																
Fats	Total Solids	+	−	+	−	+	−	Count	Extraneous matter	Chemical	Bacterial	Liquors for License Dept.	Miscellaneous Specimens	Total Specimens for year	Water	Diphtheria	T. B.	Typhoid	Total Outfits	Doses of Anti-Typhoid Vaccine sent out	Cases	Number of Injections
											1				1				1			
1								1			10				12		5		17			
											55		21		18	24			42	3189		
												1					10		10			
											3				1				1			
											4											
											4											
									1		10				24	2	2	2	30			
											1											
																					2	37
																	5		5	19		
											7				3				3	180		
											4											
											1				1				1			
										4	257	167	98		30	128			158	3189	27	570
															1				1			
											24	96	4		26	72	2		100	18	2	42
											2											
											4				6	6			12			
											2				1				1			

REPORT OF THE BRANCH LABORATORY OF THE BOARD AT KINGSTON

The Chairman and Members of the Provincial Board of Health.

GENTLEMEN,—I have the honour to submit the report of the work done in the local Laboratory of the Provincial Board of Health during the year 1916.

In this period 7,700 specimens were examined as per appended table.

Diphtheria :—		
Swabs for Release from Quarantine		788
Positive	228	
Negative	560	
Swabs for Diagnosis		583
Positive	143	
Negative	440	
Sputums for Tubercle Bacilli		1,099
Positive	250	
Negative	849	
Blood for Typhoid Reaction		797
Positive	243	
Negative	554	
Water for Bacteriological Analysis		747
Milk for Examination (Preservatives, Tubercle Bacilli, etc.)		21
Miscellaneous Samples, including Pus, and particularly Naso-pharyngeal Swabs for Meningococci		3,665
Total		7,700

The work of the Branch Laboratory continues to increase, the number of samples being 7,700 as against 5,445 last year.

Respectfully submitted,

W. T. CONNELL,

Assistant Bacteriologist.

REPORT FROM BRANCH LABORATORIES OF THE PROVINCIAL

Municipalities	Diphtheritic Swabs				Tuberculous Sputa		Typhoid Bloods		Rabies Diagnosis			
	Release		Diagnosis						Animal	Negri Bodies		Animal Inoculations
	+	−	+	−	+	−	+	−		+	−	
Algoma—												
Thessalon								1				
Bruce—												
Paisley			1					9				
Carleton—												
Manotick			2	7		1		2				
Ottawa					1		1					
Richmond						1						
Metcalfe			1			4		5				
Dundas—												
Brinston						1		1				
Chesterville						2		1				
Iroquois				2								
Morrisburg						1	1	3				
Winchester				1	1	7		1				
Essex—												
Essex						2						
Frontenac—												
Barriefield						6		1				
Flinton							1	3				
Harrowsmith				8	3		1	4				
Inverary												
Kingston	198	475	70	269	73	493	62	286				
Portsmouth	3	29	1	3	81	42	2	4				
Sharbot Lake								2				
Sydenham					1	3	2	5				
Verona						4	1	4				
Wolfe Island						1		4				
Glengarry—												
Dalhousie Mills						1						
Dalkeith					1							
Lancaster				1		1						
Maxville				1	2							
Williamstown					1	3						
Grenville—												
Cardinal					2							
Jasper							1					
Kemptville					1	3	1	6				
Merrickville					4	10	2	2				
Prescott		2	1	3	2	2	2	6				
Spencerville						1						
Hastings—												
Bancroft					2	3	4	2				
Belleville			4	11	10	26	11	14				
Foxboro			1	2	2	1	1	1				
Frankford												
Deseronto					2	2						
Madoc						1		1				
Marlbank						4		1				
Marmora						1						
Melrose					1							
Roslin					2	2	2	2				
Shannonville					1	1		1				
Trenton					1	3						
Tweed					3	1						
Huron—												
Wingham	2	1	4	2	1	8		3				

BOARD OF HEALTH OF ONTARIO AT KINGSTON FOR THE YEAR 1916.

Milk										Waters		Liquors for License Dept.	Miscellaneous Specimens	Total for Year
Food Content		Preservatives		Bacteriological					Extraneous Matter	Chemical	Bacterial			
				Tubercle Bac.		Pus Cells		Count						
Fats	Total Solids	+	—	+	—	+	—							
											1			
											1			
											83		3	
											2			
											4			
											2			
3	3		3		3		3	3	3		324		2745	
											22		5	
													22	
											2		2	
											5			
													18	
											1		1	
											5		230	
											4		10	
											1		2	
											2			
													1	

REPORT FROM BRANCH LABORATORIES OF THE PROVINCIAL BOARD

Municipality	Diphtheritic Swabs				Tuberculous Sputa		Typhoid Bloods		Rabies Diagnosis			
	Release		Diagnosis						Animal	Negri Bodies		Animal Inoculations
	+	−	+	−	+	−	+	−		+	−	
Lanark—												
Carleton Place			2	1	1	5	3	7				
Lanark						2						
McDonald's Corners					1	2		1				
Perth				4	2	1	2					
Smith's Falls			1	2	4	8	90	38				
Leeds—												
Brockville	1	6	1	4	4	14	12	26				
Chaffey's Lake												
Delta												
Elgin				1			1	4				
Gananoque	1	2	3	2	3	10	2	4				
Lansdowne			1	22		1	2	8				
Mallorytown				1								
Newboro						3	1					
Westport		1	3	3	1			2				
Lyn												
Lennox and Addington—												
Bath					2	7		1				
Denbigh					1	1						
Napanee				2	5	14	1	11				
Newburg				1		4	1	1				
Odessa					2	12	4	3				
Tamworth				6		3	1	10				
Yarker				1	1	5	13	16				
Manitoulin—												
Gore Bay				3								
Northumberland—												
Campbellford					1			1				
Cobourg						6	1	5				
Port Hope						2		1				
Warkworth						3						
Hastings			1			3		2				
Nipissing—												
Milner												
Peterborough—												
Peterborough					2	6	1	3				
Prescott—												
Fournier	8	12	3	3		2		2				
Hawkesbury					1	4		2				
Vankleek Hill						5	1	1				
Prince Edward—												
Picton					3	6	1	2				
Renfrew—												
Arnprior				2		4						
Calabogie		3	2			2						
Cobden		6		1	1	8	1	1				
Douglas				3	1	9						
Forester's Falls						1						
Killaloe					1	7						
Pembroke			4	2	3	21						
Petawawa												
Renfrew	3	5	8	13	4	12	4	8				
Russell—												
Bourget	7	15	16	30	1							
Clarence Creek			2									
Simcoe—												
Barrie				2		1	1	6				

OF HEALTH OF ONTARIO AT KINGSTON FOR THE YEAR 1916.—*Continued.*

Milk										Waters.		Liquor for License Dept.	Miscellaneous Specimens	Total for year
Food Content		Preservatives		Bacteriological					Extraneous Matter	Chemical	Bacterial			
				Tubercle Bac.		Pus Cells		Count						
Fats	Total Solids	+	—	+	—	+	—							
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	1	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	8	...	...	...
...	...	...	...	...	...	...	...	...	...	...	2	...	10	...
...	...	...	...	...	...	...	...	...	...	...	115	...	503	...
...	...	...	...	...	...	...	...	...	...	...	3	...	...	...
...	...	...	...	...	...	...	...	...	...	...	3	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	2	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	3	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	2	...	...	...
...	...	...	...	...	...	...	...	...	...	...	1	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	16	...	14	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	10	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	52	...
...	...	...	...	...	...	...	...	...	...	...	98	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	21	...
...	...	...	...	...	...	...	...	...	...	...	...	...	14	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	1	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	1	...	...	...
...	...	...	...	...	...	...	...	...	...	...	12	...	...	...
...	...	...	...	...	...	...	...	...	...	...	4	...	...	...
...	...	...	...	...	...	...	...	...	...	...	4	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	4	...
...	...	...	...	...	...	...	...	...	...	...	4	...	2	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

REPORT FROM BRANCH LABORATORIES OF THE PROVINCIAL BOARD

Municipalities	Diphtheritic Swabs				Tuberculous Sputa		Typhoid Bloods		Rabies Diagnosis			
	Release		Diagnosis						Animal	Negri		Animal Inoculations
	+	−	+	−	+	−	+	−		+	−	
Stormont—												
Aultsville	....	....	1	......	1	......	....	......	......	....	....	......
Cornwall	....	....	6	11	4	6	5	7	......	....	....	......
Finch	5	3	3	2	1	2	....	......	......	....	....	......
Newington	....	....	1	8	......	4	1	5	......	....	....	......
Temiskaming—												
Cobalt	....	....	....	......	......	1	....	......	......	....	....	......
Victoria—												
Lindsay	....	....	....	......	......	1	....	1	......	....	....	......
Grand Total	228	560	143	440	250	849	243	554	......	....	....	......

OF HEALTH OF ONTARIO AT KINGSTON FOR THE YEAR 1916.—*Concluded.*

Milk										Waters		Liquors for License Dept.	Miscellaneous Specimens	Total for Year
Food Content		Preservatives		Bacteriological					Extraneous Matter					
				Tubercle Bac.		Pus Cells		Count						
Fats	Total Solids	+	—	+	—	+	—			Chemical	Bacterial			
......	......	......	......	......	......	......	....	......	....	......	......	....	....	......
......	......	......	......	......	......	......	....	......	....	......	......	....	3	......
......	......	......	......	......	......	......	....	......	....	......	......	....	....	......
......	......	......	......	......	......	......	....	......	....	......	......	....	....	......
......	......	......	......	......	......	......	....	......	....	......	......	....	1	......
......	......	......	......	......	......	......	....	......	....	......	......	....	....	......
3	3	......	3	......	3	......	3	3	3	......	747	....	3665	......

REPORT OF THE BRANCH LABORATORY OF THE BOARD AT LONDON (INSTITUTE OF PUBLIC HEALTH)

The number of Laboratory examinations made by the Branch Laboratory of the Provincial Board of Health at London (Institute of Public Health) in 1916 shows a marked increase over 1915. The increase was 35 per cent. There has also been an increase of 20 per cent. in the number of communities taking advantage of the laboratory service.

Examination.	1915	1916	Increase.
Diphtheria Swabs	1,472	2,512	71%
Tuberculous Sputa	484	955	97%
Typhoid Blood	243	197	–20%
Milk (samples examined for fats and preservatives)	377	....	–100%
Milk (Bacteriological Analysis)	125	....	–100%
Water (Chemical Analysis)	152	169	11%
Water (Bacteriological Analysis)	155	221	30%
Total	3,008	4,050	35%
Communities served	80	96	20%

H. W. Hill,

Director.

REPORT FROM BRANCH LABORATORIES OF THE PROVINCIAL BOARD

Municipalities	Diphtheritic Swabs				Tuberculous Sputa		Typhoid Bloods		Rabies Diagnosis			
	Release		Diagnosis						Animal	Negri Bodies		Animal Inoculations
	+	—	+	—	+	—	+	—		+	—	
Brant—												
Paris		2	1	6								
Bruce—												
Chesley						1						
Lucknow					1	5						
Paisley												
Walkerton				5		2						
Durham—												
Millbrook						3						
Elgin—												
Dutton		2		3		2						
Lawrence Station					1	2						
St. Thomas			1	8	1		1	2				
West Lorne		5		3		1						
Essex—												
Comber								3				
Essex		1				1		1				
Ford City		4										
Harrow			3	1								
Kingsville						1		1				
Sandwich		2				1		1				
Walkerville		4		4		1						
Windsor	9	48	8	41	1			3				
Halton—												
Campbellville					1							
Huron—												
Brucefield						1						
Clinton							1	2				
Crediton		2		2								
Goderich								2				
Hensall						1						
Wingham				1		2						
Zurich		1		1				2				
Haldimand—												
Dunnville							1					
Kent—												
Blenheim				14		3	3	8				
Chatham		1		2	2	12		2				
Dresden					1			3				
Duart					3	1						
Exeter								1				
Merlin						1						
Ridgetown		1			1	5	1	3				
Thamesville		1		2		3	1					
Tilbury		1	1		1							
Wallaceburg			1		1	1	2	2				
Wheatley						3						
Lambton—												
Arkona		1	1	2	2			1				
Brigden		1		1		2						
Camlachie	3	2		1				1				
Courtright						2						
Florence						1						
Forest				1		2						

OF HEALTH OF ONTARIO AT LONDON FOR THE YEAR 1916.

Milk										Waters		Liquors for License Dept.	Miscellaneous Specimens	Total for year
Food Content		Preservatives		Bacteriological					Extraneous Matter	Chemical	Bacterial			
				Tubercle Bac.		Pus Cells		Count						
Fats	Total Solids	+	—	+	—	+	—							
......	......	......	......	......	......	......	....	....	....	......	......	....	......	9
......	......	......	......	......	......	......	....	....	....	......	......	....	......	1
......	......	......	......	......	......	......	....	....	....	......	......	....	......	6
......	......	......	......	......	......	......	....	....	....	1	1	....	......	2
......	......	......	......	......	......	......	....	....	....	......	......	....	......	7
......	......	......	......	......	......	......	....	....	....	......	......	....	......	3
......	......	......	......	......	......	......	....	....	....	......	......	....	......	7
......	......	......	......	......	......	......	....	....	....	......	......	....	......	3
......	......	......	......	......	......	......	....	....	....	......	......	....	......	13
......	......	......	......	......	......	......	....	....	....	......	......	....	......	9
......	......	......	......	......	......	......	....	....	....	......	......	....	......	3
......	......	......	......	......	......	......	....	....	....	......	......	....	......	3
......	......	......	......	......	......	......	....	....	....	......	......	....	......	4
......	......	......	......	......	......	......	....	....	....	4	4	....	......	10
......	......	......	......	......	......	......	....	....	....	2	2	....	......	8
......	......	......	......	......	......	......	....	....	....	......	......	....	......	9
......	......	......	......	......	......	......	....	....	....	......	......	....	......	110
......	......	......	......	......	......	......	....	....	....	......	......	....	......	4
......	......	......	......	......	......	......	....	....	....	......	......	....	......	1
......	......	......	......	......	......	......	....	....	....	......	......	....	......	1
......	......	......	......	......	......	......	....	....	....	......	......	....	......	3
......	......	......	......	......	......	......	....	....	....	......	......	....	......	4
......	......	......	......	......	......	......	....	....	....	3	3	....	......	8
......	......	......	......	......	......	......	....	....	....	......	......	....	......	1
......	......	......	......	......	......	......	....	....	....	......	......	....	......	3
......	......	......	......	......	......	......	....	....	....	3	3	....	......	10
......	......	......	......	......	......	......	....	....	....	......	......	....	......	1
......	......	......	......	......	......	......	....	....	....	......	......	....	......	28
......	......	......	......	......	......	......	....	....	....	6	6	....	......	31
......	......	......	......	......	......	......	....	....	....	......	......	....	......	4
......	......	......	......	......	......	......	....	....	....	......	......	....	......	4
......	......	......	......	......	......	......	....	....	....	1	1	....	......	3
......	......	......	......	......	......	......	....	....	....	......	......	....	......	1
......	......	......	......	......	......	......	....	....	....	......	......	....	......	11
......	......	......	......	......	......	......	....	....	....	......	......	....	......	7
......	......	......	......	......	......	......	....	....	....	......	......	....	......	3
......	......	......	......	......	......	......	....	....	....	......	......	....	......	7
......	......	......	......	......	......	......	....	....	....	......	......	....	......	3
......	......	......	......	......	......	......	....	....	....	......	......	....	......	7
......	......	......	......	......	......	......	....	....	....	......	......	....	......	4
......	......	......	......	......	......	......	....	....	....	......	......	....	......	7
......	......	......	......	......	......	......	....	....	....	......	......	....	......	2
......	......	......	......	......	......	......	....	....	....	1	1	....	......	3
......	......	......	......	......	......	......	....	....	....	......	......	....	......	3

REPORT FROM BRANCH LABORATORIES OF THE PROVINCIAL BOARD

Municipalities	Diphtheritic Swabs				Tuberculous Sputa		Typhoid Bloods		Rabies Diagnosis			
	Release		Diagnosis						Animal	Negri Bodies		Animal Inoculations
	+	−	+	−	+	−	+	−		+	−	
Lambton—Con.												
Inwood		1		3	2	2		1				
Oil Springs						3	1					
Petrolea	2	5	2	4	2	2						
Pt. Lambton						1		2				
Sarnia				1	1	1						
Sombra								2				
Watford	1	5	2	1	1	4		6				
Wyoming					3	2	1	3				
Lincoln—												
Grimsby								1				
Middlesex—												
Appin				1	1							
Belmont					1							
Byron				5	8	16						
Dorchester								1				
Glencoe		1			2	6						
Granton					1	2	1	1				
Harrietsville					1							
Hyde Park						3						
Lambeth						1						
Lobo		1	1									
London	180	775	134	1,144	125	631	23	75	Dog		2	
Lucan				2		3						
Melbourne						1		2				
Mt. Brydges						2						
Newbury					3							
Parkhill		3		3								
Poplar Hill						1						
Strathroy								1				
Thorndale					1							
Wardsville						2						
London Twp												
Norfolk—												
Langton						1						
Northumberland—												
Cobourg						1						
Oxford—												
Embro					1	2						
Ingersoll				5	1	4		2				
Lakeside					1	2		1				
Mount Elgin												
Norwich				1								
Plattsville					1							
Tavistock												
Thamesford				2		2						
Tillsonburg				1				2				
Woodstock				2	1	7	1	4				
Perth—												
Listowel								2				
St. Mary's		1		2	3	3		2				
Stratford				3	2	4	1					

OF HEALTH OF ONTARIO AT LONDON FOR THE YEAR 1916.—*Continued.*

Milk										Waters		Liquors for License Dept.	Miscellaneous Specimens	Total for Year
Food Content		Preservatives		Bacteriological					Extraneous Matter					
				Tubercle Bac.		Pus Cells		Count						
Fats	Total Solids	+	−	+	−	+	−			Chemical	Bacterial			
...	...	...	...	...	...	...	...	...	...	...	...	...	...	9
...	...	...	...	...	...	...	...	...	...	...	...	...	...	4
...	...	...	...	...	...	...	...	...	...	...	...	...	...	17
...	...	...	...	...	...	...	...	...	...	1	1	...	...	5
...	...	...	...	...	...	...	...	...	...	...	...	...	...	3
...	...	...	...	...	...	...	...	...	...	...	...	...	...	2
...	...	...	...	...	...	...	...	...	...	...	...	...	...	20
...	...	...	...	...	...	...	...	...	...	...	...	...	...	9
...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
...	...	...	...	...	...	...	...	...	...	...	...	...	...	2
...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
...	...	...	...	...	...	...	...	...	...	...	...	...	...	29
...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
...	...	...	...	...	...	...	...	...	...	2	2	...	...	13
...	...	...	...	...	...	...	...	...	...	3	3	...	...	11
...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
...	...	...	...	...	...	...	...	...	...	...	...	...	...	3
...	...	...	...	...	...	...	...	...	...	3	3	...	...	7
...	...	...	...	...	...	...	...	...	...	3	3	...	...	8
...	...	...	...	...	...	...	...	...	...	61	113	...	...	3,263
...	...	...	...	...	...	...	...	...	...	1	1	...	...	7
...	...	...	...	...	...	...	...	...	...	...	...	...	...	3
...	...	...	...	...	...	...	...	...	...	3	3	...	...	8
...	...	...	...	...	...	...	...	...	...	...	...	...	...	3
...	...	...	...	...	...	...	...	...	...	...	...	...	...	6
...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
...	...	...	...	...	...	...	...	...	...	...	...	...	...	2
...	...	...	...	...	...	...	...	...	...	1	1	...	...	2
...	...	...	...	...	...	...	...	...	...	1	1	...	...	3
...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
...	...	...	...	...	...	...	...	...	...	...	...	...	...	3
...	...	...	...	...	...	...	...	...	...	29	29	...	...	70
...	...	...	...	...	...	...	...	...	...	...	...	...	...	4
...	...	...	...	...	...	...	...	...	...	12	12	...	...	24
...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
...	...	...	...	...	...	...	...	...	...	1	1	...	...	2
...	...	...	...	...	...	...	...	...	...	2	2	...	...	8
...	...	...	...	...	...	...	...	...	...	...	...	...	...	3
...	...	...	...	...	...	...	...	...	...	...	...	...	...	15
...	...	...	...	...	...	...	...	...	...	...	2	...	...	14
...	...	...	...	...	...	...	...	...	...	...	...	...	...	0
...	...	...	...	...	...	...	...	...	...	...	...	...	...	10

REPORT FROM BRANCH LABORATORIES OF THE PROVINCIAL BOARD

Municipalities.	Diphtheritic Swabs				Tuberculous Sputa		Typhoid Bloods		Rabies Diagnosis			
	Release		Diagnosis						Animal	Negri Bodies		Animal inoculation
	+	—	+	+	+	—	+	—		+	—	
Thunder Bay—												
Pt. Arthur				1								
Waterloo—												
Galt				12	1	1	1					
Kitchener						1	1	1				
New Dundee						2	1					
Wellington—												
Alma						1						
Guelph						1						
Wentworth—												
Hamilton							2	6				
Totals	195	871	155	1,291	180	775	43	154			2	

OF HEALTH OF ONTARIO AT LONDON FOR THE YEAR 1916.—*Concluded.*

Milk										Waters		Liquors for License Dept.	Miscellaneous Specimens	Total for year.
Food Content		Preservatives		Bacteriological					Extraneous Matter	Chemical	Bacterial			
				Tubercle Bac.		Pus Cells		Count						
Fats	Total Solids	+	—	+	—	+	—							
......	......	......	......	......	......	......	....	....	....	......	......	....	......	1
......	......	......	......	......	......	......	....	....	....	6	6	....	......	27
......	......	......	......	......	......	......	....	....	....	17	17	....	......	37
......	......	......	......	......	......	......	....	....	....	......	......	....	......	3
......	......	......	......	......	......	......	....	....	....	......	......	....	......	1
......	......	......	......	......	......	......	....	....	....	......	......	....	......	1
......	......	......	......	......	......	......	....	....	....	......	......	....	......	8
......	......	......	......	......	......	......	....	....	....	169	221	....	......	4,050

Provincial Board of Health of Ontario Experimental Station

BULLETIN No. 5

SOME EXPERIMENTS ON SOLUBILITY OF ALUM

By MISS G. E. GALLINGER, B.A.
Assistant Chemist Experimental Station

REPORT UPON FILTER ALUMS USED IN ONTARIO

By MISS G. E. GALLINGER and MESSRS. A. V. DeLAPORTE and F. A. DALLYN

DESIRABLE FEATURES FOR ALUM FEED APPARATUS USED IN WATER PURIFICATION PLANTS

By F. A. DALLYN, C.E.
Provincial Sanitary Engineer

A COMPILATION OF RECOMMENDED METHODS FOR THE PHYSICAL AND CHEMICAL EXAMINATION OF SEWAGE AND WATER

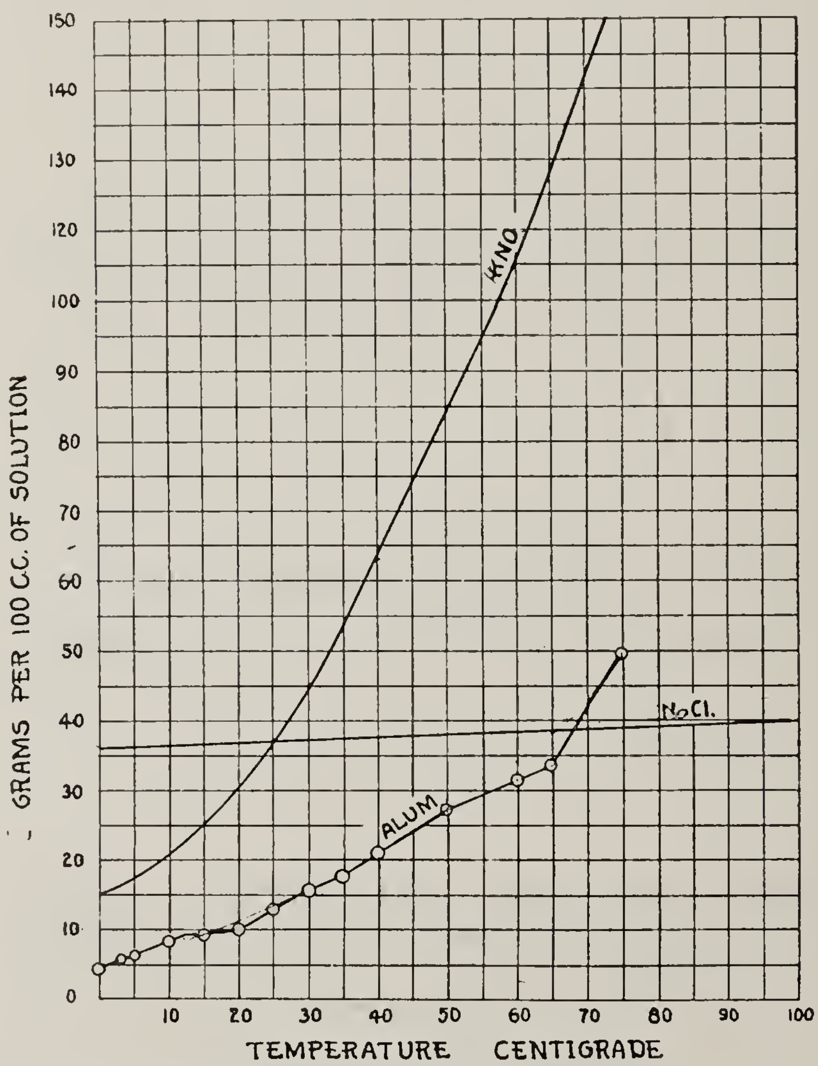
By A. V DeLAPORTE, B.A.Sc.
Chemist in Charge of Experimental Station

SOME EXPERIMENTS ON THE SOLUBILITY OF ALUM.

By Miss G. E. Gallinger, B.A.

In many purification plants prior to sand filtration and chlorination, alum is used as a precipitant. In view of the different types of alum feed apparatus now on the market, or in course of design, it is a fundamental necessity that some appreciation be had of the behaviour of alum in solution. Published information regarding the physical properties of alum was found to be very meagre, and the experiments herein reported upon have been performed in the Laboratory of the Provincial Board of Health Experimental Station, for the purpose of demonstrating and making available certain facts and information bearing on the solubility of alum.

The Solubility of Alum at Different Temperatures and in Different Solvents.



Comparison of the Effect of Temperature on the Solubility of Alum, Potassium Nitrate and Common Salt

Early experiments on the solubility of alum showed that a solubility table for filter alums at different temperatures cannot readily be made. Examination of numerous samples of commercial alum at the Experimental Station shows that the composition of the different commercial alums varies greatly, even alum shipped by the same company from week to week varies in composition and consequently in solubility. In several experiments the difficulty of obtaining a recrystallization of certain filter alums was also experienced; this seemed to be due to the formation of colloidal solutions, or because of some new phase in the solution.

In the experiments herein reported a white crystalline ammonium alum was used, containing upon analysis Al_2O_3 10.8 per cent.; SO_3 31.0 per cent.; Fe_2O_3 .006 per cent.; NH_3 4.5 per cent.; FeO nil; insoluble matter nil.

Bacteriological Laboratory, Experimental Station.

Chemical Laboratory, Experimental Station.

The results of the tests are believed to be reasonably accurate, and it may be mentioned that great difficulty was experienced in obtaining a technique for these experiments, and that, even with the greatest care and accuracy, it was very difficult to overcome error in result. The amount of work necessary was also considerable, more than one hundred titrations being made in some instances for each, considered temperature when determining the rate of solubility.

The accuracy of the solubility determinations depended on the fact that the temperatures used were all beyond the transition interval; it is impossible otherwise, according to Findlay, to dissolve alum, a double salt, in water without decomposition.

While performing the solubility experiments very slight variation in results was encountered, one or two exceptions, however, were notable. On one occasion although the temperature had been lowered from 60° C. to 35° C., the solubility did not decrease for several hours. This result may have been due to transformation and to the existence of a metastable phase in the solution, since it is known that the phase most stable under the given conditions is not always the one found to be present in the system. In this particular case even after some solid alum was introduced into the system the transition to the new phase took place very slowly.

A peculiar phenomenon was noticed on several occasions during experiments on the rate of solution of alum at higher temperatures. As the solution became more highly concentrated, having been in contact with the solvent for several hours, it was found upon analysis that the percentage of alum dissolved decreased for a time then resumed a normal increase; this variation was probably due to some action of the alum on the glass at the higher temperatures.

METHOD.

The solubility was taken as the amount of alum that will dissolve in a given amount of liquid at a given temperature; and a saturated solution as representing a state of equilibrium between two phases, the solution and the undissolved substance.

The solvent was heated in an open vessel* with excess alum to a temperature higher than that at which the solubility was to be determined. The solvent was then cooled to the required temperature in contact with the solid. A part of the solution, after the excess of alum above that required to form a saturated solution had separated out, was removed, and the amount of the dissolved substance contained in it was determined by volumetric analysis. The solubility was expressed as the number of grams of the solute taken up by 100 parts by volume of the solvent.

A solution of the alum saturated at 100° C. was allowed to cool and samples were taken at different temperatures. The samples were titrated against a standard solution of sodium hydroxide of such strength that 1 c.c. NaOH was equivalent to 0.01 grams of alum. The solubility was given directly from the difference in the burette readings. The experiments were all carried out on a laboratory scale and glass beakers of 600 c.c. capacity were used. A water-jacketed oven was used in

*The effect of pressure on solubility of alum, determined by Von Stackelberg, shows that at 18° C. with a pressure of 1 atmosphere, the solubility of alum is 0.115, while with a pressure of 500 atmospheres the solubility is 0.142. Pressure makes a very slight alteration of solubility, and for practical purposes the solubility, as determined under atmospheric pressure, is taken as the true solubility, that is, the solubility when the system is under pressure of its own vapour.

these experiments, and the temperature was kept constant through the use of a thermostat gas regulator. Sufficient time for complete separation of the solid at each temperature was allowed before the samples were taken.

TECHNIQUE.

Placed 250 c.c. of liquid in a 600 c.c. beaker, heated to boiling and added alum until some remained undissolved, allowed solution to cool until temperature was 75° C, then placed beaker in a constant temperature oven for approximately one hour. After stirring well transfer sample to a beaker through a pipette, heated to same temperature as sample. Washed pipette with 10 c.c. of hot water; added one drop of indicator and titrated against standard sodium hydroxide. This method was used in each experiment.

Referring to Table No. I, column 1, the solubility of alum in Toronto tap, Lake Ontario water, increases very slowly at the lower temperatures but with increase of temperature above 20° C. the solubility rises with considerable rapidity.

With the present equipment in many water purification plants it is impractical to heat the alum solution water; in such plants, it is, therefore, evidently impossible to either store or feed alum in the form of a highly concentrated solution.

In column II and column III the solvent action of a slightly acid water is shown. With a 0.1 per cent. sulphuric acid solution the solubility at low temperatures is below that of water, but above 45° C. the acid solution forms a better solvent than water. The same is true of a 1 per cent. sulphuric acid solution.

At ordinary temperatures tap water is a better solvent than a sulphuric acid solution, and the presence of sulphuric acid in solution has a retarding effect on alum solubility.

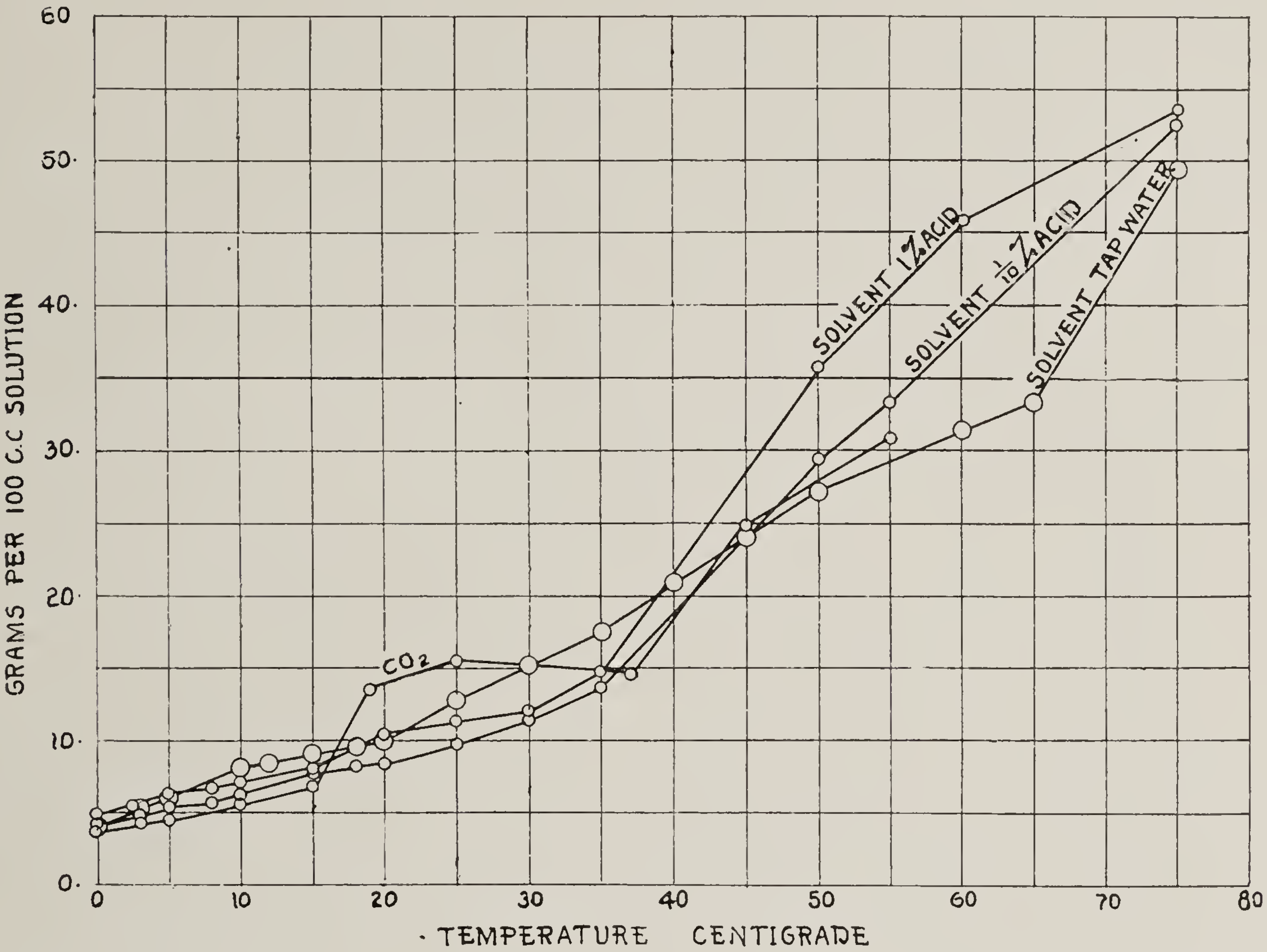
Column IV shows the solubility of alum in a saturated solution of carbon dioxide. The solubility is also much less at low temperatures than in water, but it is greater than water at temperatures above 45° C.

The experiments show that the temperature coefficients of solubility are invariably positive within the temperature range 0° C. to 75° C. The curve representing the change of concentration of the components in the solution with the temperature shows considerable irregularity, possibly due largely to the production of different phases in the system and also to the changes in the density of the solvent with change of temperature.

Using the results obtained by Senter for potassium nitrate and sodium chloride solubility, a direct comparison with alum has been made on page 124. A very low alum solubility between temperatures of 0° C. and 25° C. is apparent.

Rate of Solution of Alum.

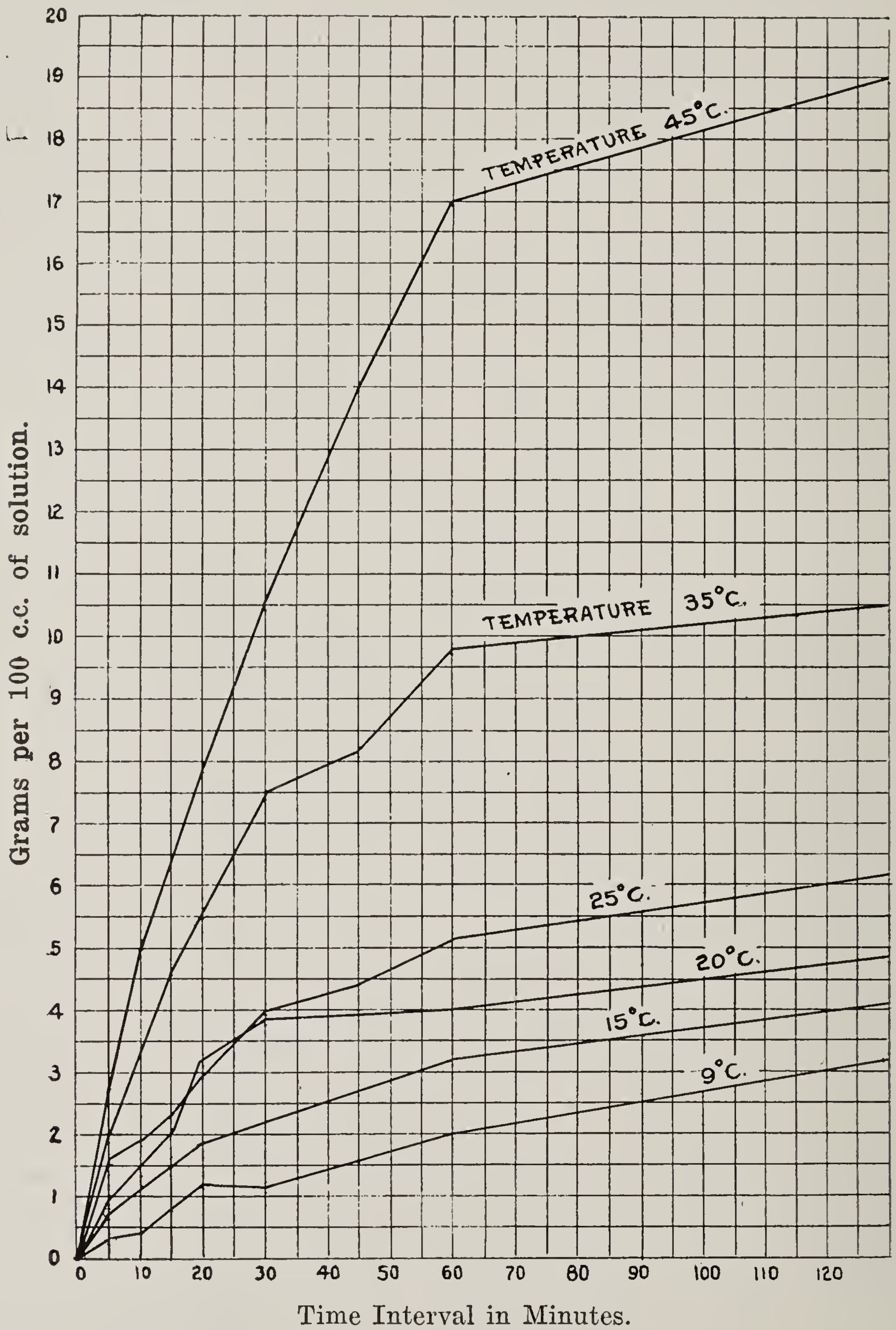
250 c.c. tap water of a definite temperature were placed in a 600 c.c. beaker. A definite quantity of alum was added, care being taken to use crystals of uniform size in each experiment. Samples were taken at different intervals and titrated as before against standard NaOH.



SHOWING THE EFFECT OF TEMPERATURE UPON SOLUBILITY OF ALUM IN SEVERAL SOLVENTS.
TABLE No. 1.

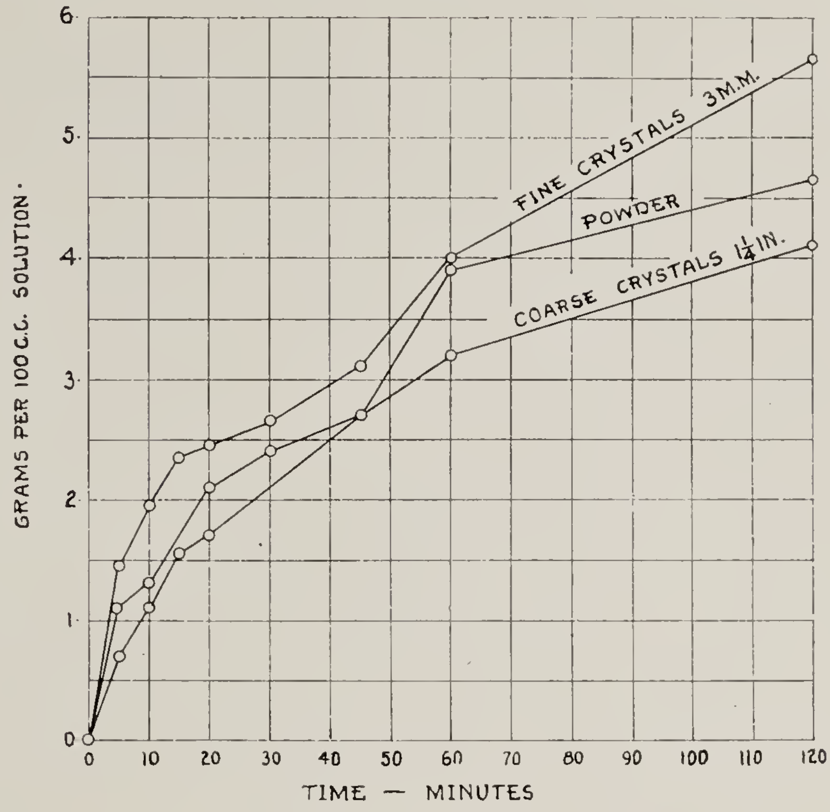
Temperature.	Column I.	Column II.	Column III.	Column IV.
Degrees Centigrade.	% alum solubility when using tap water, Toronto, Ont.	% solubility when using 0.1% H_2SO_4 medium, and distilled water.	% solubility when using 1.0% H_2SO_4 medium, and distilled water.	% solubility when using CO_2 medium, and distilled water.
0	4.0	4.1	4.9	3.85
3	5.2	4.7	5.5	4.3
5	6.0	5.5	6.2	4.5
8	....	5.65	6.6	....
10	8.0	6.2	7.0	5.6
12	8.5	....	....	....
15	9.0	7.6	8.0	6.8
18	9.5	8.1	....	....
19	....	....	....	13.5
20	10.0	8.3	10.4	....
25	12.7	9.7	11.2	15.3
30	15.1	11.4	12.0	....
35	17.5	13.65	14.7	....
37	....	....	....	14.5
40	20.9	....	....	....
45	24.0	....	....	24.9
50	27.0	29.5	35.8	....
55	....	....	....	31.2
60	31.5	33.3	45.8	....
65	33.2	....	....	....
75	49.5	52.5	53.5	....

No determinations made at these temperatures.



Showing Rate of Solution of Alum in Tap Water at Different Temperatures.
Table No. 2.

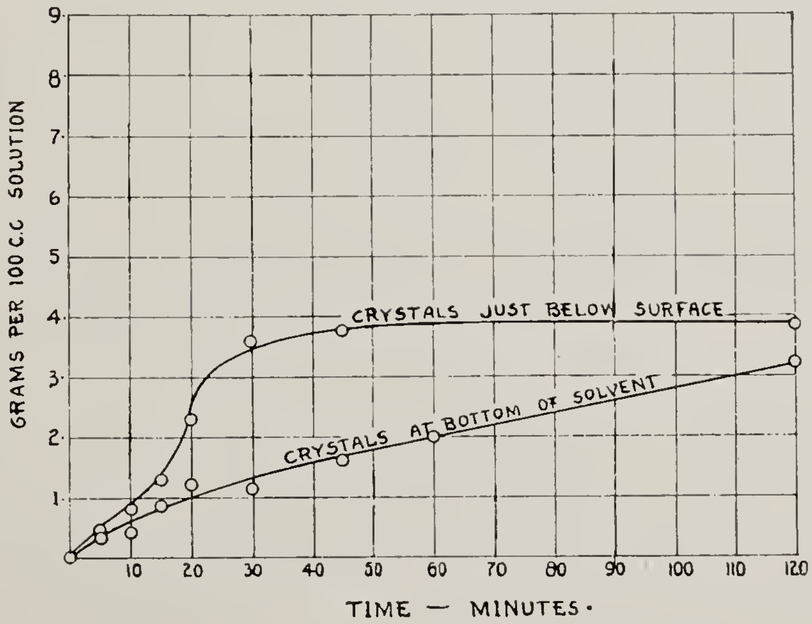
Temperatures Centigrade.	After 5 min.	After 10 min.	After 15 min.	After 20 min.	After 30 min.	After 45 min.	After 60 min.	After 2 hours.
9°	.3	.4	.85	1.2	1.15	1.6	2.0	3.2
15°	.7	1.1	1.55	1.7	....	2.7	3.2	4.1
20°	.95	1.4	2.0	3.2	3.85	3.9	4.0	4.85
25°	1.6	1.9	2.3	3.0	4.0	4.4	5.15	6.2
35°	1.95	3.3	4.65	5.55	7.45	8.15	9.8	10.5
45°	2.8	5.05	....	7.9	10.5	14.0	17.0	19.0



SHOWING EFFECT OF SIZE OF ALUM CRYSTALS UPON RATE OF SOLUTION. TABLE NO. 3.

No.	Temperatures Centigrade.	After 5 min.	After 10 min.	After 15 min.	After 20 min.	After 30 min.	After 45 min.	After 60 min.	After 2 hours.
*1	15°	1.1	1.3	....	2.1	2.4	2.7	3.9	4.65
2	15°	1.45	1.95	2.35	2.45	2.65	3.1	4.0	5.65
3	15°	.7	1.1	1.55	1.7	....	2.7	3.2	4.1

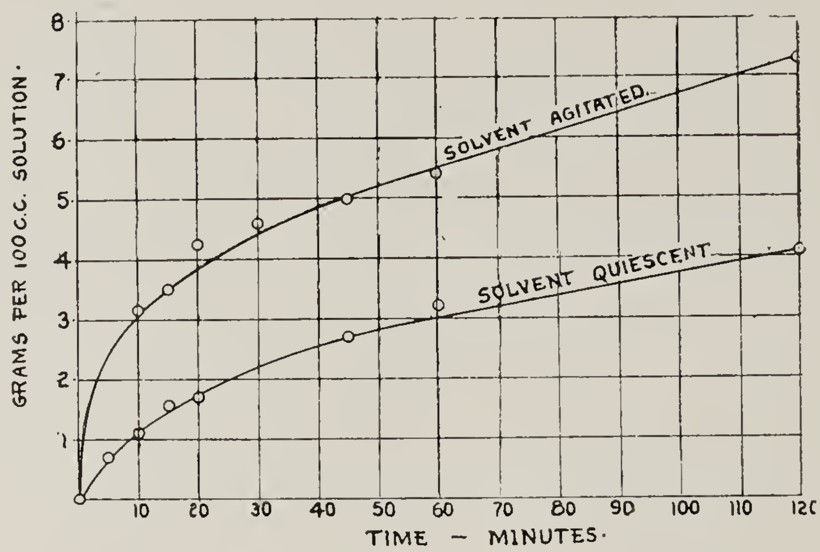
*1. Powdered alum; 2. 3 mm. crystals; 3. 1¼ inch crystals.



SHOWING THE INFLUENCE OF THE POSITION OF ALUM CRYSTALS IN SOLVENT UPON RATE OF SOLUTION OF ALUM. TABLE NO. 4.

	Temp. C.	5 min.	10 min.	15 min.	20 min.	30 min.	45 min.	60 min.	2 hr.
No. 1.......	15°	.7	1.1	1.55	1.7	....	2.7	3.2	4.1
No. 2.......	15°	.6	1.25	1.6	1.85	2.15	2.7	3.65	4.3

No. 1 crystals placed at bottom of solvent.
No. 2 crystals placed in basket just below surface of solvent.



Showing Effect of Using Agitation to Assist Diffusion. Table No. 5.

Temp. C.	after 5 min.	10 min.	15 min.	20 min.	30 min.	45 min.	60 min.	2 hrs.	Treatment.
15°	2.6	3.15	3.5	4.25	4.6	5.0	5.4	7.3	Solution constantly agitated by electric stirrer throughout experiment.
15°	.7	1.1	1.55	1.7	......	2.7	3.2	4.1	Solution stirred just before taking samples.

In tap water alum dissolves very slowly at low temperatures. At 9° C. after two hours the solution was only 41.5 per cent. of saturation (1 C. the ratio of 3.2 to 7.7) but at a temperature of 45° C. after two hours the solution was 79.2 per cent. of saturation (1 C. the ratio of 19.0 to 24.0).

With a weak acid solution the rate of solution is faster than with water. In 20 minutes at 15° C. 1.75 grams had dissolved per 100 c.c. of water, while 2.5 grams had dissolved in weak acid. This accelerating action of acid may be due to dissociation.

Showing the Influence of Solvents Other Than Water Upon Rate of Solution of Alum. Table No. 6.

Temp. C.	5 min.	10 min.	20 min.	30 min.	45 min.	60 min.	2 hrs.	Solvents.
15°	1.2	1.55	2.0	2.5	3.05	3.15	4.25	Using 0.1% H_2SO_4.
15°	1.05	1.3	1.45	1.9	2.75	3.05	4.2	Using 1.0% H_2SO_4.
15°	.7	1.1	1.75	......	2.7	3.2	4.1	Using tap water. Temp. hardness 94.

Showing Rate of Solution of Alum in 0.1% H_2SO_4. Table No. 7.

Temp. C.	5 min.	10 min.	15 min.	20 min.	30 min.	45 min.	60 min.	2 hrs.
5°	....	....	....	....	....	....	....	....
8°	.4	....	1.2	....	2.5	3.6	3.7	4.0
15°	1.2	1.55	2.0	2.5	....	3.1	3.15	4.25
18°	1.4	....	2.1	....	3.6	4.8	5.8	6.7
20°	1.6	2.5	2.8	3.45	4.1	4.9	6.1	7.45
30°	1.9	2.8	3.3	3.9	5.1	6.1	6.5	7.9
35°	2.3	3.9	6.7	8.3	9.9	12.1	13.0	12.4
45°	3.9	6.1	....	8.4	12.5	14.5	15.3	18.6

Rate of Solution of Alum in 1% H_2SO_4. Table No. 8.

Temperature Centigrade.	5	10	15	20	30	45	60	2 hrs.
5°	....	....	....	....	....	....	....	....
10°	1.5	1.7	2.8	3.1	3.5	3.8	4.8	5.8
15°	1.05	1.3	1.45	1.9	....	2.75	3.05	5.2
25°	1.7	1.9	2.8	4.0	4.5	6.0	8.4	9.3
35°	1.9	3.0	5.1	6.9	8.2	11.3	13.7	16.5
45°	5.2	7.0	....	8.5	11.5	12.6	15.1	20.6

Showing the Rate of Solution of Alum at 10° C. Table No. 9.

Condition of Solvent or Position of Solute	After 5 min.	After 10 min.	After 15 min.	After 20 min.	After 30 min.	After 45 min.	After 60 min.	After 2 hrs.
Using tap water as solvent and 1¼ in. crystals placed at bottom of solvent	.3	.4	.85	1.2	1.15	1.6	2.0	3.2
Using tap water as solvent and crystals placed in basket just below surface of liquid	.45	.8	1.3	2.3	3.6	3.75	....	3.85
Using powdered alum ...	.55	.9	1.25	1.4	1.95	2.5	3.3	3.95
Using 3 m.m. crystals...	.45	1.1	1.3	1.6	1.85	3.0	3.4	4.55
Using 0.1% H_2SO_4 solvent and distilled water	.4	....	1.2	....	2.5	3.6	3.7	4.0
Using tap water and agitating liquid constantly with an electric stirrer	1.7	2.2	3.9	4.0	4.1	4.2	4.6	6.2

Crystals of alum placed at the bottom of a solvent dissolve much more slowly than when the crystals are near surface of solvent, since the dissolved alum is denser than the solvent and hence does not diffuse except by displacement, and it may be possible in a vessel containing a saturated solution in the bottom to have less than 1 per cent. of saturation in the top. See Table 10.*

*TABLE 10.

Samples taken from	% Alum in Solution After 1 day,	After 5 days.
0 bottom of cylinder	7.82	7.82
3 upper coil of crystals	7.82	7.82
4— 1″ above crystals	.....	1.50
5— 2″ " "	.....	0.96
6— 3″ " "	.....	0.50
7— 4″ " "	.....	0.49
8— 5″ " "	0.48	0.48
9— 6″ " "	.....	0.47
10— 7″ " "	.....	0.47
11— 8″ " "	.....	0.45
12— 9″ " "	.....	0.44
13—10″ " "	0.41	0.41
14—11″ " "	.....	0.41
15—12″ " "	.....	0.41
16—13″ " "	.....	0.41
17—14″ " "	.....	0.41
18—15″ " "	.....	0.41

*Experiment by Mr. O. Lye, 1915. Provincial Board of Health Experimental Station.

Agitation has a marked effect on rate of solution owing to the slow rate of diffusion, due probably to the formation of pockets.

From the experiments it may be seen that the concentration of the alum solution can be increased in several ways, provided always that an excess of solid alum is in contact with the solution. The most important factor influencing the concentration of alum in solution is the temperature. Time also must be considered as the rate of solution is low enough to affect the size of alum feed tanks used in filtration plants, about four hours is required to dissolve the quantity of alum being used in ordinary plants. Another very important factor is the means adopted to promote diffusion. Agitation when dissolving alum increases the rate of solution so considerably that agitation or stirring devices are of great value in mixing drums. Their advantage in stock solutions is, however, negligible.

REPORT UPON FILTER ALUMS USED IN ONTARIO.

By Miss G. E. Gallinger and Messrs. A. V. DeLaporte and F. A. Dallyn.

The development of water purification in the Province, and more especially, the introduction of rapid sand filter plants, has brought new and peculiar duties to the Board of Health. At present an important matter under consideration is the quality of alum or sulphate of alumina offered for sale for water purification purposes. It is extremely necessary that a proper or satisfactory aluminium sulphate should be used in connection with the operation of mechanical filters.

For the past ten years the smaller municipalities in Ontario have been purchasing alum to satisfy their local requirements, amounts ranging from two to twenty tons per annum—through local supply houses or druggists. The importance of the filter alum supply has recently been greatly enhanced through the completion at Toronto of a water purification plant requiring the purchase of from 700 to 900 tons of alum per annum.

The investigation of the various filter alums supplied through the local agencies was undertaken by the staff at the laboratory at the Board's Experimental Station. The return of inquiry sheets showed, with few exceptions, that the alum supplied to smaller municipalities had passed through four or five hands before reaching them, and that the price paid by adjoining municipalities for aluminium sulphate varied widely. During the last two years the prices have varied from 1.9 cents to as high as 7 cents per lb., depending on the amount purchased; the latter represents the prices when purchased in small quantities.

Apart from the economic question of added cost, there is grave danger, when the local agency is unaware of the source of supply, that alum furnished in this way may be found unsuitable for the purpose of water purification. Several striking incidents of this nature were discovered during the laboratory investigation.

The investigation also revealed the fact that the average municipality purchased its alum without a knowledge of what was required.

The analysis of the alums received by the Board appear in Table No. 1.

TABLE No. 1.

ANALYSIS OF FILTER ALUMS OFFERED FOR SALE IN ONTARIO AND USED 1916-1917.

Source of Filter Alum (Municipality)	Al_2O_3	SO_3	Basicity ratio	Fe_2O_3	FeO	Insoluble matter	NH_3
Toronto, July 13th, 1917	19.5	38.6	.138	0.375	0.34	trace	....
Toronto, Aug. 8th, 1917	19.5	37.6	.015	0.4	0.37	0.4	....
Perth	19.4	40.6	.06	0.275	0.23	0.079	....
St. Thomas	19.3	39.0	.10	0.4	0.37	0.1	....
Toronto, Sept. 12th, 1917	19.3	32.2	.3	0.46	0.41	0.056	.05
Dundas	18.8	43.3	.02	0.3	0.25	trace	.03
Toronto, July 24th, 1917	18.7	38.9	.011	0.4	0.37	trace	.04
Toronto, July 31st, 1917	18.7	41.2	.025	0.5	0.47	trace	....
Haileybury	18.7	38.0	.01	0.3	0.28	0.1	.03
Toronto, Aug. 31st, 1917	18.64	33.7	.25	0.58	0.53	0.07	.028
Lindsay (lump)	18.56	38.2	.128	0.47	....	0.2	....
Renfrew	18.2	38.6	.098	0.35	0.31	0.075	....
Cobourg	18.2	36.3	.16	0.3	0.27	0.05	....
Toronto, Sept. 19th, 1917	18.1	33.0	.24	0.58	0.54	nil	1.1
New Toronto	17.9	32.7	.022	0.40	0.05	6.4	....
Toronto, Sept. 12th, 1917	17.9	32.9	.23	0.45	0.40	0.08	.028
Iroquois Falls	17.8	32.0	.286	0.58	0.57	0.24	.05
Orillia	17.7	37.9	.094	0.35	0.345	trace	....
Stratford	17.7	38.3	.08	0.3	0.26	trace	....
Lindsay (ground)	17.6	38.7	.06	0.495	....	0.25	....
Kitchener	17.5	39.8	.01	0.3	0.22	0.1	....
Toronto, Sept. 27th, 1917	17.4	32.9	.21	0.45	0.43	0.23	....
Toronto, July 10th, 1917	17.2	38.0	.059	0.3	0.27	trace	....
Toronto	17.0	38.5	.035	0.3	0.21	0.1	....
Toronto, Aug. 2nd, 1917	16.9	36.6	.089	0.45	0.42	0.1	....
Weston (ground)	16.48	32.7	.14	0.01	0.005	0.16	....
Niagara-on-the-Lake	15.8	37.2	.01	0.5	0.4	trace	.026
Weston (lump)	14.0	33.2	free acid 1.1	0.04	0.03	0.12	....
Dunnville	12.8	35.5	0.1	trace	trace	trace	4.5
Maximum of each part	19.5	43.3	.300	.58	.57	6.4	4.5
Minimum of each part	12.8	32.0	free acid 1.1	trace	trace	nil	nil

NOTE.—Aluminium Sulphate should be judged and purchased on its water soluble aluminium content and on the excess of $Al_2O_5H_4$ over what is required theoretically to combine with sulphuric acid. Estimated on the basis of 17% Al_2O_3 at 2 cents per pound, an alum, 19.5% Al_2O_3, is worth ⅓ cent more, which is equivalent to a discount of 16½ per cent., and an alum 12.8% Al_2O_3 is worth ½ cent less and represents a loss of 25%. The 12.8% Al_2O_3 referred to was purchased at 5 cents per pound, and the loss was at least 1¼ cents per pound irrespective of the original high cost.

Lump alum or sulphate of alumina is a combination of bauxite—a southern clay containing 58 per cent. to 60 per cent. alumina, the aluminium being present as $Al_2O_5H_4$, with sulphuric acid.

The process most generally employed for manufacturing sulphate of alumina consists firstly in mixing bauxite with sulphuric acid in lead lined tanks, then boiling for a period of from six to eight hours. The solution formed after the reaction between bauxite and acid has taken place, is a mixture of $Al_2(SO_4)_3$ and silica; and in order to obtain a clear solution it is necessary to filter the mixture. This filtering process is difficult, tedious and costly. The alum solution is next boiled to expel the excess water. After being concentrated from a density of 25° or 30° Baume to a density of 50° or 60° Baume, the solution is discharged into trays, and on cooling it crystallizes to alum cake. This cake is then crushed or pulverized and is shipped in bulk, barrels or sacks.

A good basic aluminium sulphate should be in lumps from one-half to two inches in diameter. It should contain not less than 17 per cent. of water soluble aluminium calculated as Al_2O_3, and should have a basicity ratio of 0.03 or, in other words, should contain one-half of one per cent. of Al_2O_3 more than is theoretically required to combine with the sulphuric acid present. It should not have more than one per cent. as total iron. An excess of bases over the amount required to combine with the total acid present is a necessity and is a point that is overlooked in the purchase of alum by most municipalities.

TABLE No. 2.

ESTIMATE OF THE PRESENT USE OF ALUM FOR WATER PURIFICATION IN ONTARIO.

Municipality	Pounds alum used per annum	Water gallons pumpage per annum	Water pumpage per 24 hours	Pounds alum used per 24 hours	Estimated grains alum per imp. gallon
Abitibi Pulp and Paper Mills, Iroquois Falls	14,400	94,900,000	260,000	40	1.1
Amherstburg (projected)..	....	....	750,000	106	1.0
Arnprior.................	300	146,000,000	400,000	52	1.5 (not in use)
Chatham.................	40,000	474,300,000	1,300,000	110	0.6
Cobourg..................	13,000	3,723,000	1,002,000	36	0.26
Dundas..................	17,155	117,530,000	322,000	47	1.1
Dunnville................	6,000	182,500,000	500,000	15	0.2
Haileybury...............	45,000	73,000,000	200,000	125	4.4
Kitchener................	14,600	361,250,000	312,000	40	0.9
Lindsay (under construction)..................	58,000	....	1,152,000	160	1.0
New Toronto.............	64,000	....	1,250,000	175	1.0 to 0.75
Niagara-on-the-Lake......	3,400	73,000,000	200,000	9.5	0.33
Ojibway (projected)......	50,000	....	1,000,000	140	1.0
Orillia..................	45,600	200,750,000	700,000	125	1.38
Oshawa (in construction)..	22,800	159,610,533	438,000	62	1.0
Perth....................	18,000	200,000,000	500,000	50	0.7
Renfrew.................	9,660	371,500,000	1,017,882	26.5	0.35
St. Thomas..............	5,400	622,744,480	1,815,820	150	0.58
Stratford................	25,000	372,700,000	10,204,640	69	0.49
Toronto..................	1,600,000	10,950,000,000	30,000,000	4,384	1.1
Weston..................	3,600	55,000,000	175,000	10	0.4

To insure quality in aluminium sulphate and to make an appreciable saving, the municipalities using chemical and filtering their water should combine with each other and either manufacture their own aluminium sulphate or purchase it by annual contract according to the proposed specifications from one of several manufacturers. Without introducing the economic aspects of the question, the benefits to be derived from this co-operation are most apparent when the municipalities realize that manufacturers can give them exactly what they require with possibly a reduction in the cost of manufacture, provided the quantities and dates of shipment are reasonably apparent in the *annual* contracts. Until such action is taken the purchasing agent for each municipality should be instructed, even when buying small quantities of aluminium sulphate, to secure one which fills the following specifications:

Specifications for Filter Aluminium Sulphate.

The basic aluminium sulphate shall be in lumps from one-half to two inches in diameter and shall contain not less than 17 per cent. water soluble aluminium calculated as Al_2O_3. It shall have one-half to one per cent. of Al_2O_3 in excess of the amount theoretically required to combine with the sulphuric acid present. It shall not contain more than seven to ten per cent. insoluble matter in cold water and not more than one per cent. total iron.

Provided that a proper grade of bauxite filling the required specifications for alum-making is used, manufacturers should not find it difficult to supply aluminium sulphate according to the above specifications.

In paper mills, or for other industries where the pure article is needed, it is essential to use a sulphate of alumina containing not more than one-tenth to one per cent. insoluble matter in cold distilled water. For water purification, however, a refined alum is not necessary, and, in fact, it is not nearly so active a coagulant as alum containing a fairly high percentage of insoluble matter.

Table No. 2 is an estimate of the present use of alum and the dosage administered in the several municipalities operating rapid sand filters. It is to be observed that quantities greater than 2.5 grains per gallon and less than 0.5 grains are either excessive and wasteful, promoting corrosion in water service pipes and fittings, or inadequate, permitting insufficiently treated water to pass through filters.

Table No. 3 is a rough forecast of the use of alum in the Province, mention being made only of the municipalities using alum at the present time. This table may be of interest to industries in a position to manufacture alum, or capable of supplying an equally satisfactory substance for the use of water purification plants. The number of municipalities employing rapid sand filtration should, in a few years, be considerably increased and the amount of alum used in the Province for water treatment will be about 1,500 tons per annum.

Table No. 3.

Forecast of Use of Filter Alum in Ontario.

——	1916	1920	1925	1935
Estimated pounds of alum used..........	1,891,115	2,220,725	2,673,610	4,560,381

This decided increase in alum consumption, together with the problem of a suitable quality of alum at a nominal cost, makes it highly desirable to consider the practicability of manufacturing filter alums within the Province.

At the present time there is only one firm, to our knowledge, manufacturing alum in Canada. Most of the filter alum used in Ontario is imported either from Great Britain or the United States. A plant for making alum to coagulate water was recently built at the Columbus Water Purification Works, Ohio. According to *Charles P. Hoover this plant (1915) is a success both technically and economically, and between 800 and 1,000 tons of alum are manufactured per year. The cost of manufacture in 1915 was about $10.50 per ton. For this process sulphuric acid of not less than 92 per cent. is used and a bauxite containing not less than 52 per cent. Al_2O_3, and not more than 3 per cent. Fe_2O_3. Bauxite can readily be secured, containing from 58 to 60 per cent. Al_2O_3. The filter alum should contain at least

*Journal of American Waterworks Association, Dec., 1915.

17 per cent. Al_2O_3, and one ton of bauxite will serve for at least three tons of alum, $Al_2(SO_4)_3\ 14\ H_2O$. The manufacture of alum in Ontario at the point where it is to be used would be of great economic advantage, especially in that it increases our local market for sulphuric acid wherever large quantities of filter alum are required, and this coincides very well with the points of manufacture of sulphuric acid; also there is a decided advantage in hauling less than one-third the tonnage over railways now known to have very congested traffic conditions. Alum made at some central water purification plant can readily be shipped to adjacent municipalities in a solid form.

The importation of bauxite would probably be from the Southern States of America where it is mined quite extensively. There is no record of any bauxite in Canada. The shales and clays of Ontario seldom give as high as 20 or 21 per cent. Al_2O_3 and except the ordinary process is to be changed, are not suitable for the manufacture of alum.

The laboratory services of the Board have been extended to include the making of analysis of filter alums, with the hope that the municipalities will take full advantage of this means of checking shipments.

DESIRABLE FEATURES FOR ALUM FEED APPARATUS IN WATER PURIFICATION PLANTS.

F. A. Dallyn, C.E. (Tor.).

Alum—aluminium sulphate—is used almost exclusively, for coagulation, in that type of water purification plant known as the rapid sand or mechanical filter.

There are many types of these rapid sand filters, but certain fundamental principles of design are the same, that is to say, the sand must be of sufficient coarseness to pass the water without great resistance, (that is, resistance greater than the equivalent of the loss of head of four feet), and a filtering media must be artificially introduced into the sand, in order to strain the sediment, turbidity, or organisms from the water as the case may be. The straining layer or filter matte, for these various functions, however, need not be quite the same.

Usually, in municipal water supplies the removal of the very finely suspended turbidity and of micro-organisms, including bacteria, is the essential duty of the plant, and the usual specifications for sand provides for an effective size, ranging from .43 millimeters to about .5 millimeters. Coarse sand filters of this type, without the use of an artificial filter matte, do not effectively remove either fine turbidity or bacteria. The exceptional case is when water contains considerable slime and organic matter, and it is then possible for the filter to take up a certain efficiency. In this way efficiencies as low as 30 to 40 per cent. have been observed without the introduction of an artificial filter matte. But operating efficiencies of 95 to 97 per cent. cannot, however, be obtained.

The function of the coagulant is to create a jelly-like surface on the sand grains. This builds up until it practically interlocks, and a film is created, descending into the filter possibly several inches, and held by cohesive force. The matte, without offering extreme resistance to the flow of water, serves to strain out matters held in suspension.

The film reaches its maximum efficiency in from four to eight hours, after the filter is put in operation. If the water contains considerable turbidity, the matte may become so tight, after ten hours, that the pressure of water—especially in the pressure plant type—may overcome the cohesive force of the coagulant and rupture the filtering layer. When this occurs large volumes of water, improperly strained, find access to the underdrains of the filter.

The whole operation of filtering depends upon the presence of an unruptured film in the filter. One of the main reasons for the preference, in municipal purification plants, towards the gravity type of mechanical filter, is because of the fact that extreme pressures do not tend to arise in ordinary filter operation, pressures such as would rupture the straining film and the film continues unbroken except a plant attendant mischievously pokes his filter with bars. The effect of the filtering layers plugging, in the gravity plants, is to offer more resistance to the passage of water and decrease the filter capacity. A constant rate of flow may be maintained within certain limits by interposing a balanced control valve. These valves maintain a constant rate of flow by gradually cutting out a back-pressure (that is, the back pressure is permitted to decrease as the discharge of the filter decreases).

The rapid sand and other mechanical filters are designed essentially for the removal of the turbidity and the whole underdrainage and sand washing system must permit of a successful washing operation being carried out. In back-washing the ordinary type, the sand strainers act like a set of orifices for regulating the pressure at the face of the sand and distribute evenly the upward flow. By regulating the velocity of the upward flow any turbidity or material deposited on the filter

may be lifted and carried to the wash water troughs, and the operation depends specially on the manner in which the aluminium hydrate is formed and held on the top of the sand and the ease with which it can be dislodged and washed away when the flow to the filter is reversed in the washing operation.

In Ontario we have twenty plants of the rapid sand type with several more in course of construction and others in contemplation. Most of the plants are of the pressure type. A few are of the gravity type with some examples of the drifting sand filters. And it is imperative that further attention should be given to the manner in which the alum is introduced into the water for the promotion of the requisite straining layers. For the purpose of discussion, apparatus for feeding alum may be grouped into three natural divisions: (1) Apparatus capable of feeding from 15 to 100 pounds of alum per day, (2) apparatus capable of feeding from 100 to 300 pounds of alum per day, and (3) apparatus capable of feeding from 300 and upwards pounds per day.

Where a municipality has considerable standpipe or reservoir capacity and operates its fire pumps on off-peak periods, to keep the standpipe full, Class 1 may emerge into Class 2 or Class 2 emerge into Class 3, because the whole of the dosage may be delivered within an interval of a few hours. When no standpipe or reservoir is used, and the pumps operate continuously day and night, the classes are much better defined and can be grouped as indicated.

1.

Difficulties of feed are most apparent when centrifugal pumps are used against the closed system, that is, a system without a standpipe for equalizing draft. In such systems the use of a venturi or other meter for determining pumpage is absolutely imperative not only for the determination of dosage of alum but for proper control of the administration of disinfectants, such as bleaching powder or liquid chlorine, which are now generally included with water treatment plants.

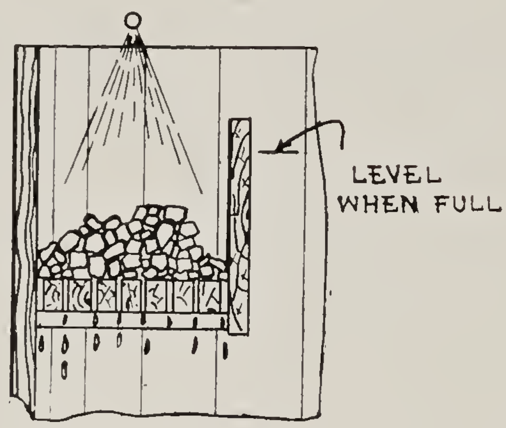
It may, therefore, be taken for granted that at each water purification works the rate of pumpage can be definitely known, and as far as possible wide variations within the hours of pumpage eliminated except in the case of fires.

Having in mind the results of filter operation both in Ontario and elsewhere there appears to be no great advantage in the minute control of the quantity of alum reaching the raw water, especially in Class 1, and in Classes 2 and 3 the control should only be such as would effect reasonable economy in the quantities of alum introduced.

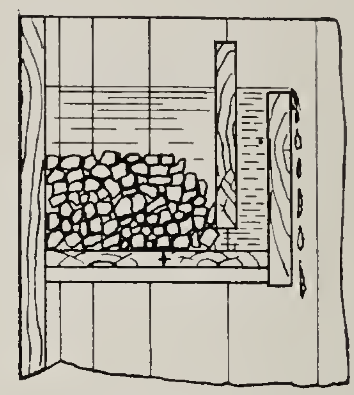
The article by Miss G. E. Gallinger with reference to the solubility of alum, shows that with temperatures falling below 5° C., which are not at all uncommon in this Province, especially during winter, that a 5 per cent. solution cannot be readily realized except there be a long interval of contact or else the solutions be made with warm water.

In the older plants, and in some of the more recent ones, the proper weight of alum is measured out on scales, placed on a dissolving rack "A" and put into solution by a jet of water flowing over it and falling freely through a slotted base in to the storage tank, or else the measured quantity of alum is completely immersed as in arrangement "B." Both of these arrangements are perfectly satisfactory if the measured quantity of alum dissolves completely before the solution tank is quite full. Unfortunately, for quantities exceeding 30 or 40 pounds, this is not usually the case unless hot water is used.

In arrangement "A," the solving action for any residue may continue, because the specific gravity of the concentrated alum solution is much heavier than the solution in the tank and the heavy saturated solution may descend through the



A



B

slots. In arrangement " B " there is no opportunity for any further solving action after the solution in the tank rises above the partition.

In any apparatus it must be recognized that alum dissolves very slowly in cold water. Some observations were made and they showed that not more than ten pounds out of fifty pounds immersed in water or exposed to a spray will normally dissolve in one hour at temperatures below 10° C.

If arrangements "A" and "B" are used without heating the water the valves must be very carefully set in order that the tank does not fill quickly. With "A" after the tank is full the solving action proceeds much slower than is the case when the water is being forced through the crystals.

To provide against trouble only hot water should be used with arrangements "A" and "B" and the flow regulated so that the tank does not fill before the alum is completely dissolved.

Mixing devices are not necessary if the solution tanks can be agitated by the water added finally to complete the proper quantity for the given weight of alum. The agitation is accomplished by carrying down a one-inch pipe to the bottom of the tank and terminating the down pipe with a 45°elbow about three inches above the bottom.

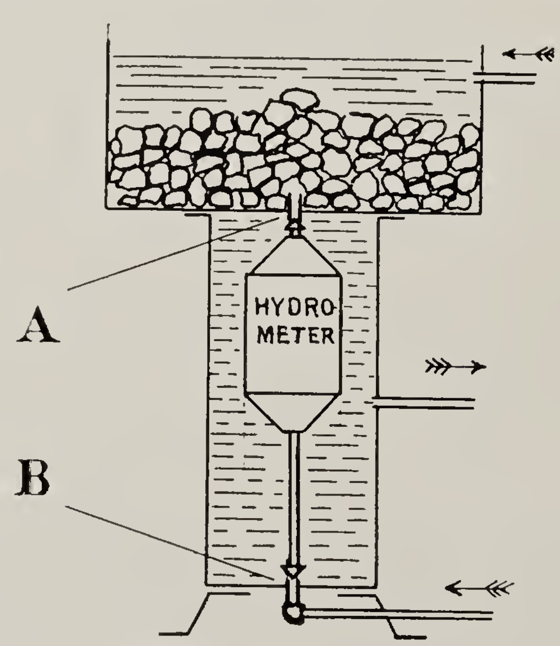


Diagram C.

The Ver Mehr Engineering Company have an ingenious arrangement shown in diagram "C" and further commented upon on page 146. This arrangement makes use of a hydrometer which regulates the flow from the storage tank, containing a saturated solution of alum, and water taken from the supply main. A constant strength solution determined by the setting of the hydrometer can be delivered at the outlet of the balancing chamber. The apparatus is ingenious, and when the arrangement permits of large quantities of alum being placed in the

storage part of the apparatus it presents some very satisfactory features, especially when used to fill storage solution tanks. Its advantages are questionable for small direct feed arrangements since the strength of the solution will usually be above 3 per cent. and tends to corrode and clog the small orifices normally used.

The apparatus, however, has some very decided advantages and the cost as compared with the installation of hot water arrangements should determine whether it is economically advisable or not. *This apparatus may with advantage replace the old pressure type shown in Diagram "D."* The use of the old pressure type is always limited by the fact that the strength of a saturated alum solution varies with the temperature and with the particular grade of alum used.

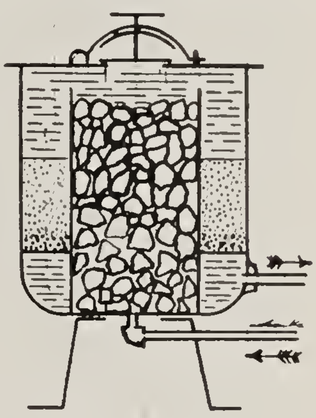
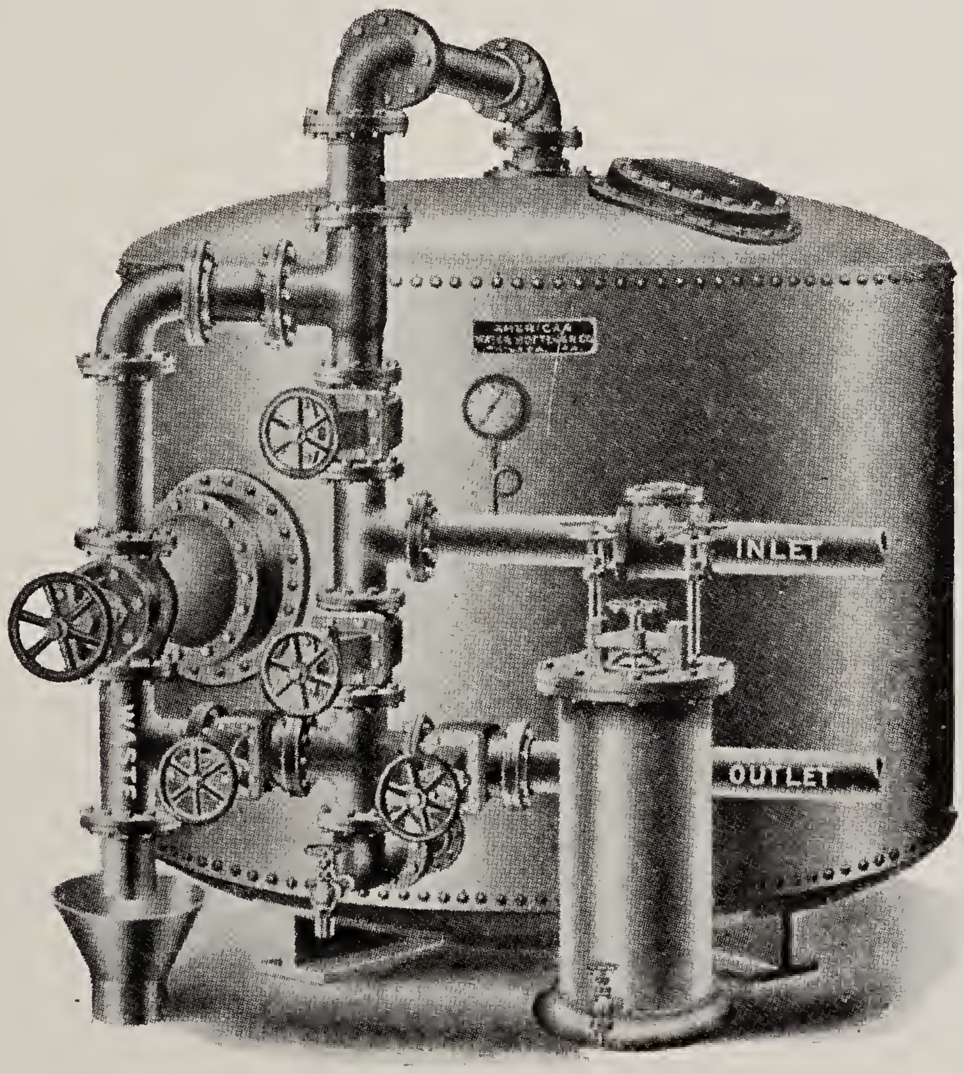


Diagram D.

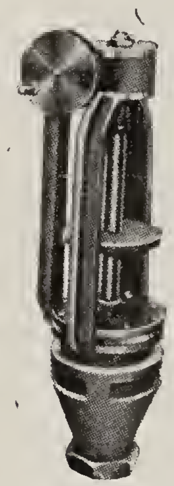
Orifices for the pressure type of apparatus are arranged to pass very small quantities of solution per 24 hours, and the feed is forced through the apparatus first by interposing a resistance on the force main and then second by by-passing two leads to the apparatus, one before the resistance and one after. A difference of pressure on the opposite sides of the feed apparatus must be secured in order to cause movement The disadvantages of the old type are apparent and little further need be said. The single advantage is that the solution feed is housed very simply and where an irregular dosage of alum it is of very little consequence, as in the case of treating water for a swimming pool, the old pressure type may be used.



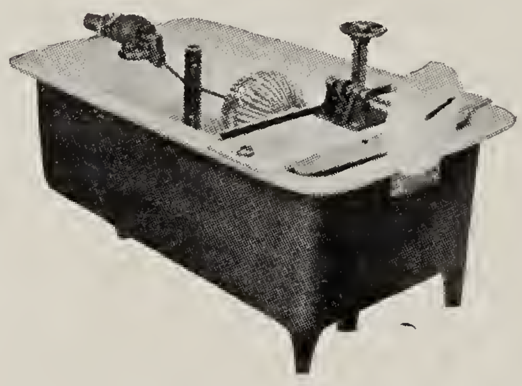
A common pressure type arrangement for hotels or hospitals

Hotels and hospitals frequently filter water taken from city mains and in such situations there is no opportunity for feeding into a low pressure point; apparati similar to the old type or to that of the Ver Mehr Company are then required.

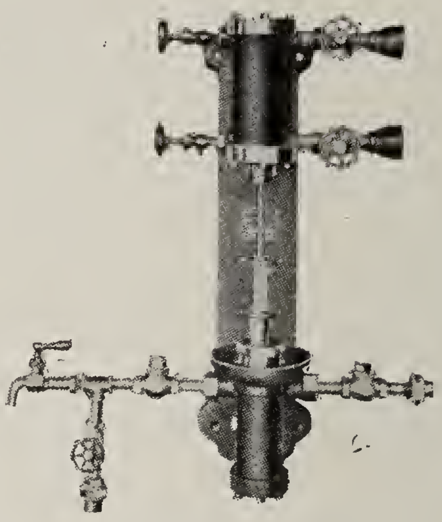
The equipment required for regulating the flow either to the suction of a pump or to the pump well is very simple. An orifice box is arranged as shown in



Orifice.



Orifice Box.



Chemical Pump.

the cut, with a slide closure type of orifice and a ball-cock float for maintaining a determined level. If the solution is to be fed to the pump suction a connection to the water main is interposed between the orifice feed and the pump in order that air will not be drawn through the feed line in case the orifice clogs. A water connection also permits the use of a larger pipe and does away with the need for small valve openings; the excess water fed in this case acts similar to the valve in restraining the flow of the solution.

Orifice boxes had better be purchased directly from one of the filter manufacturing companies who are supplying satisfactory equipment for this purpose. The orifice is usually operated with a head of about 6 inches. The head is always

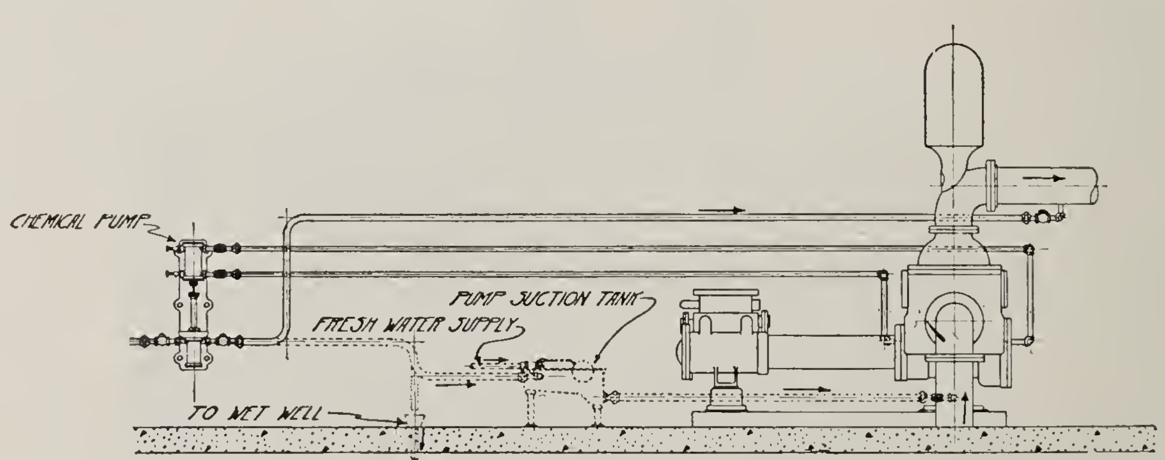


Diagram showing pump connections or connection to a wet well.

specified at the time the valve is calibrated. For ordinary operation the valve may be calibrated for the average pumpage during portions of the 24 hours. The pump attendant or person having control of the alum feed should make a practice of regulating the orifice valve at certain intervals without regard to the operation within these periods. This manner of operation in the smaller plants yields very satisfactory results, and there appears to be little advantage in installing expensive types of flow regulators actuated from venturi tubes or other measuring mechanisms in such cases.

The solution tanks should not be less than 4 ft. 0 in. diam. and 3 ft. 6 in. deep when full. They should, except in special cases, be in duplicate, and the dissolving tray or compartment should have a capacity of not less than seventy-five pounds below the water level, when the perforated rack is used. The main thing for the medical officer of health to remember is that the solution must be of constant strength, and in order to get this without difficulty it is advisable to put in hot

water heaters. Hot water heaters are now on the market which use steam, gas or electricity as the heat element, so that there remains no situation where such apparatus cannot be immediately installed and the plant rearranged to take advantage of it.

For all installations, where it is proposed to use small orifices, a filter should be provided and the solution thus treated before it reaches the orifice. The apparatus in the cut filters the solution as it is elevated to the storage tanks. Where filters have not been thought of a small filter one foot square can usually be recessed in the bottom of the storage tank. Coarse sand or fine gravel is used and it is cleaned by back-washing in the same manner as the rapid sand filters.

Apparatus at Lindsay for elevating alum or a solution to storage tanks.

2.

Practically all that has been said with respect to the first division is equally true here. The increased quantities of alum used, however, now permit of some new types of feed, the most common of which is the "Gauntt" dry feeder. Crushed alum is used and fed by an advancing worm to a dissolving drum or mixer. The water which puts the alum into solution is used to drive the machine (any rate of feed can be secured by gearing or through the use of cone pulleys) and to operate the paddles in the mixing drum. A "Pelton" water motor is generally used for these installations.

The "Gauntt" dry feed apparatus and the "Pelton" water motor are both standard equipment and do not cost excessively. The apparatus can be housed in a small space in these installations. Careful consideration must be given to the dissolving drum or hopper. The alum falling into the drum or hopper, as the case may be, should go into solutions as fast as it is fed forward; that means the size of the drum and the rate of flow through it must be for the worst conditions that may arise, namely, (1) extreme low temperature in the water, (2) an alum whose solubility is below the average. The expense of heating the large amounts of water necessary to run the Pelton wheel exclude its use in the general arrangement. If it is used, power other than a water motor will usually be used.

3.

What has been said previously again applies. The smaller users in this grouping will lean towards the dry feed apparatus or Ver Mehr equipment and the larger users will most probably manufacture under one of the many processes, and in this latter case a solution will be fed through proportionate feed apparatus. The design of this apparatus is, however, in itself a special field of engineering and hardly comes within the province of this paper.

The new alum feed apparatus at Toronto Filtration Plant has many novel features and shows the advantages to which Hydrometer control may be put. A description of the Toronto plant follows:

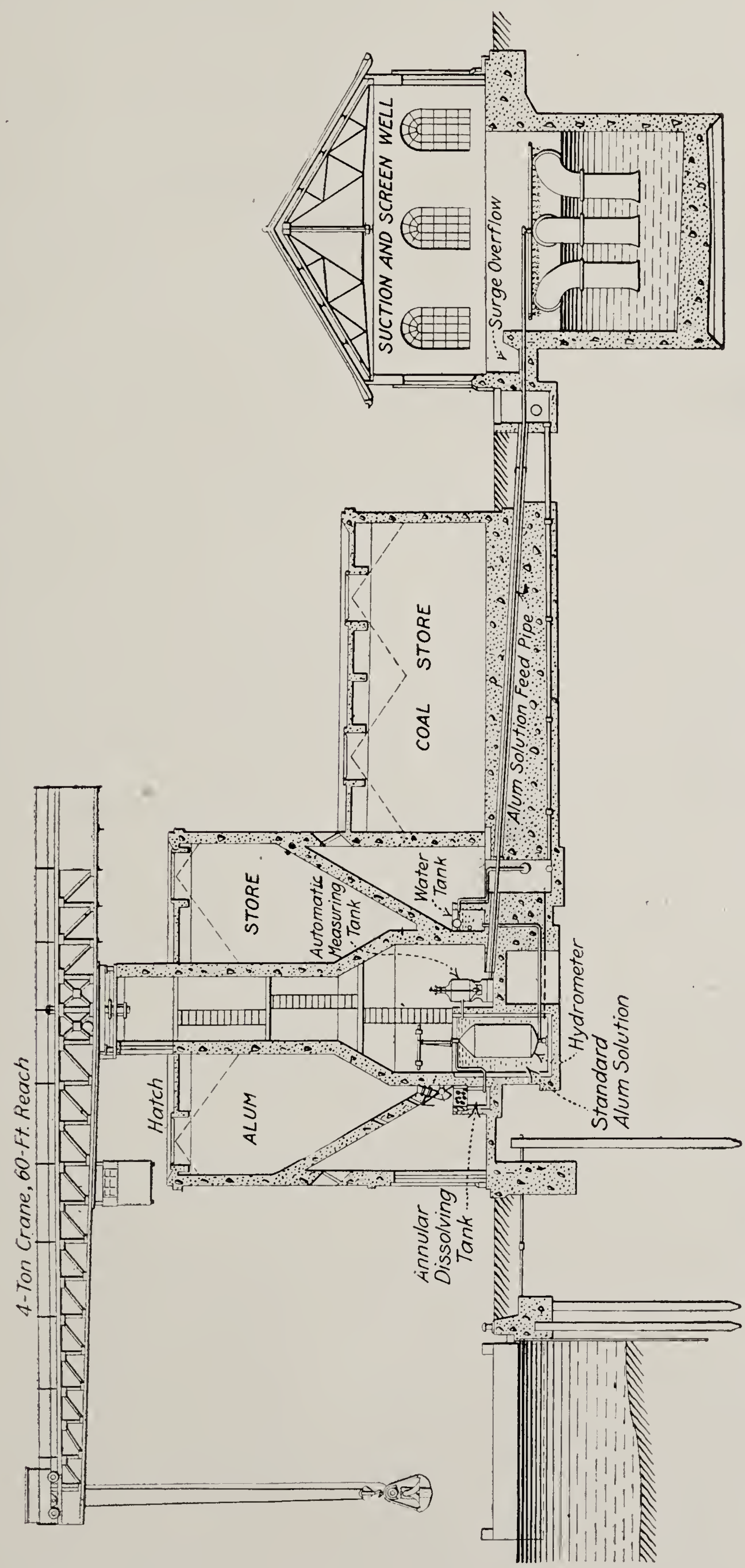
City of Toronto Gravity Plant.

Description supplied by the John Ver Mehr Engineering Co.

In this case a chemical house and coal-storage are provided of reinforced concrete with a partial brick facade, and are arranged in one group of buildings 120 x 80 ft. in order that the facilities for unloading and loading materials from the wharf shall be common to both. Storage for 1,500 tons of coal and 800 tons of aluminium sulphate is provided.

The underlying idea is to allow the dry chemical to feed down automatically from the storage bin through a number of control doors to a tray at mid-level in a dissolving channel maintained full of water. The solution formed may be of any strength in excess of 5 per cent., and this solution is fed from the bottom of the dissolving channel into a dilution tank in which it is automatically diluted down to the standard 5 per cent. by a hydrometer-like arrangement. From this tank the standard solution is fed into a measuring tank controlled by a 72-in. Venturi raw-water meter through a combined electric and hydraulic relay. From the bottom of the measuring tank the solution gravitates through lead pipes to the pump suction well and is there distributed over the water to be treated. The apparatus is in duplicate. In the section some of the parts have been displaced in order better to illustrate their working. The annular dissolving channel tank is maintained full of filtered water by a float valve. From the water tank the water flows freely to the dissolving tank or channel and after dissolving the aluminium sulphate passes through a valve at the top of the hydrometer. At the same time the water also comes from the water tank to a valve at the bottom of the hydrometer.

The hydrometer is poised in the solution between the two valves. Any vertical movement of the hydrometer opens one valve and closes the other. Thus it will let in strong solutions at the top and water at the bottom until the balance is obtained, when the hydrometer just floats in a solution containing 5 per cent. of aluminium sulphate. Any change from this strength causes the hydrometer to move and close one valve and open the other. It should be remembered that a 5 per cent. solution of aluminium sulphate is about 2½ per cent. heavier than water, and it is due to this fact that the apparatus works properly, not only from the point of view of supplying the energy to move the hydrometer, but also to mix the diluting water with the solution already in the chamber. The heavier liquid put in at the top tends to sink rapidly to the bottom, and on the other hand the lighter liquid fed in at the bottom tends to rise rapidly to the top; thus the liquid is maintained in a rapid state of circulation. A beam with knife-edges above the hydrometer provides for permanent adjustment and also for working with any desired density of solution. There is a scale with divisions for each 0.1 grain of coagulant per gallon of raw water, so that by simply moving a weight along a beam any desired amount of aluminium sulphate may be added to the water. The standard solution passes freely to the measuring tank and away to the suction well. For every rate of water passing through the raw-water meter there is a corresponding position for the hydraulic piston and gauging slot in the measuring tank. Each of these apparati is designed to dissolve and apply 12,000 lbs. of the solid chemical for 24 hours.

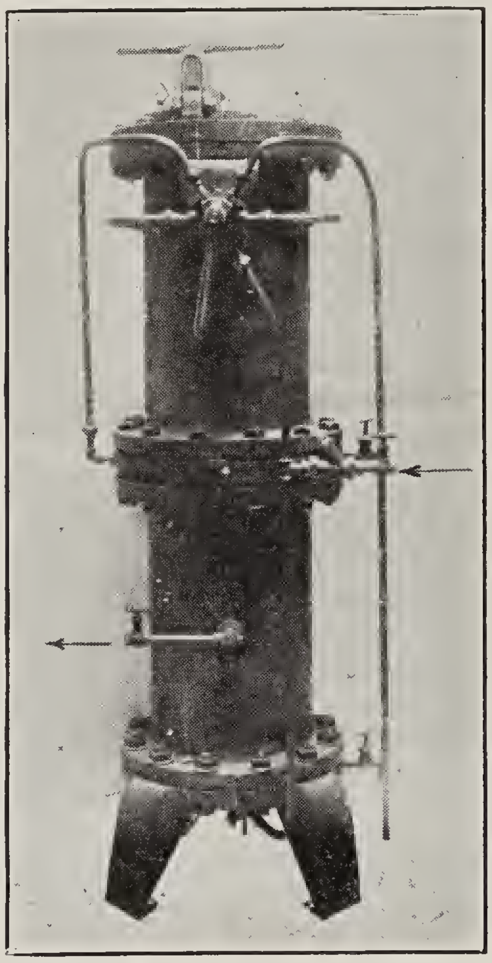


Alum Storage and Coagulant Feed Apparatus, City of Toronto Gravity Plant.

Small Pressure Coagulant Feed Apparatus.

Description supplied by the John Ver Mehr Engineering Co., Toronto, Ont.

This apparatus consists of a vertical cylinder divided into two portions of equal length. The upper length except near its bottom is unequally divided vertically, making it into a kind of U tube, in the larger leg of which is a perforated cylinder in which the solid chemicals are placed. The smaller leg serves to store solution displaced into it from the larger when charging in the solid chemical. This solution would otherwise be wasted. The upper cylinder is provided with a charging door and five-way charging cock. The lower cylinder contains the hydrometer with its needle valves at top and bottom and discharge orifice at its middle height. The inlet and outlet are connected respectively to the inlet and wedge block cavity of a gate valve on the water line. The valve is partially closed and its opening calibrated so that the loss of head produced is sufficient to draw definite quantities of coagulant through the orifice on the hydrometer cylinder for any given rate of passage of water through the valve, so that the apparatus is on a shunt to the water line and the quantities passing through it are proportional to the water passing as the same law of discharge applies to the orifice and gate valve opening.



The operation of this apparatus is as follows:—

1. To charge with sulphate of alumina, the charging five-way valve is set at charge; this by-passes the hydrometer cylinder direct to supply and releases the pressure from the upper dissolving cylinder, and the retort door can be opened. This allows water already stored in the smaller leg of the U tube to escape drawing down the solution in the larger leg, which can be replaced with the solid chemical. This proceeds until the charging is complete when the charging door is replaced and the charging lever switched over to work.

2. The whole apparatus is now under pressure again and in operation. The water drawn from in front of the partially closed gate valve is divided into two portions, one being in at the bottom of the hydrometer cylinder and the other to the top of the smaller leg of the dissolving cylinder, and ultimately down to the bottom and up past the solid chemical in the charging cylinder—becoming nearly saturated in so doing—and from thence to the top of the hydrometer cylinder. The action of the hydrometer in maintaining a solution of constant strength is the same as that described in the Toronto plant, but in this case there is no provision for a variable strength of solution which is permanently of 5 per cent. strength, and any change in the number of grains per gallon required must be made by adjusting the opening of the partially closed gate valve or by substituting other orifices. From the orifice the 5 per cent. solution passes into the water line at the wedge block cavity of the partially closed gate valve. This point is one in which the water is in a state of turbulence and rapid, thorough mixing takes place.

COMPILATION OF RECOMMENDED METHODS FOR THE PHYSICAL AND CHEMICAL EXAMINATION OF WATER AND SEWAGE.

By A. V. DeLaporte, B.A.Sc.

Chemist in charge of the Provincial Board of Health Experimental Station.

INTRODUCTION.

The standardization of methods and technique employed in the chemical examination of water and sewage throughout the Province of Ontario is most important. Municipal consulting laboratories are becoming more numerous and each analyst examines the water and sewage by the methods taught in the particular school where he had his training. These methods vary widely in some tests. The results of the tests, for which the technique varies widely, are at best but of comparative value and it is most important that there should be a standard method for examination so that the results of analysis throughout the Province may be comparable, and any departure from the standard technique should be stated in reporting results.

To expedite the use of a standard technique in the various laboratories in the Province it is proposed in this paper to give the methods employed in the Experimental Station of the Provincial Board of Health of Ontario, and to outline briefly the reason why that particular method was chosen as against other optional or recommended methods.

The Standard Methods of Water Analyses of the American Public Health Association are used as a basis, and most of the methods outlined, in the following, will be found to have a common origin with the American Public Health Association methods, but with two or three notable exceptions.

In large laboratories engaged in the examination of water or sewage, such as those of the Board of Health, that method, where there is a choice of several methods of examination, which will give the most comparable results in a minimum of time, is the method proper to employ.

The "oxygen consumed from permanganate test" is a case in point. In the standard methods of water analyses of the American Public Health Association there are several methods mentioned: (1) Digestion in the water bath for thirty minutes; (2) boiling for two minutes; (3) boiling for five minutes; (4) standing at 20°C. for four hours. As the "oxygen consumed" is a test to determine the quantity of oxygen required to oxidize the organic matter in a sample, or, in other words, an indication of the amount of reducing organic matter in the sample, a most reasonable method is to add the permanganate solution and keep the sample at a temperature of from 18° to 20°C. for a period of hours. The interval of four hours at 20°C., as given in the above mentioned report, is not, however, a sufficient length of time, at that temperature, to measure the oxygen requirement. Laboratory experience has shown that it is impracticable to keep a number of daily samples

for long periods, and that it is possible to achieve practically the same result as would be obtained by prolonged digestion at low temperature by raising the temperature and shortening the period of digestion.

"Oxygen consumed" is at best but a comparative test and it is necessary in making comparisons that the samples should be tested in exactly the same manner, consequently the temperature must be raised to the same point in each and every analysis, and digestion continued for a defined length of time. Two temperatures are readily available for digestions of this nature and can be determined without the use of thermometers and automatic temperature regulating devices; the first is obtained by using a boiling water bath, the second by raising the temperature of the acidulated sample to its boiling point. Digestion on a water bath for thirty minutes gives splendid results and is the method recommended by the American Public Health Association, but similar results are secured by boiling the sample for five minutes. To show a comparison of the methods, raw sewage was filtered with aluminium cream until it was absolutely free from suspended matter. The filtered sample was then tested for "oxygen consumed" by several methods:

Digested for 30 minutes on boiling water bath.	Boiled for 5 minutes.	Boiled for 2 minutes.	English Method standing at 20°c. for 4 hours.
3.7 c.c.	3.3 c.c.	1.6 c.c.	2.9 c.c.
3.3 c.c.	3.6 c.c.	1.7 c.c.	
3.5 c.c.	3.5 c.c.		

Results in cubic centimeters of a standard $K\ Mn\ O_4$ solution.

From the above table it will be seen that boiling for five minutes gives results almost identical with those obtained by digesting on the water bath for thirty minutes. It was therefore decided to recommend the five minute method, which is the method we now use in our laboratory.

TECHNIQUE USED FOR OXYGEN CONSUMED ON SEWAGE

The samples of sewage are arranged in proper sequence with a numbered casserole in front of each. The analyst puts 10 cc. of each sample into the casserole, and adds 90 cc. of a 2.5% solution of sulphuric acid from an automatic pipette. The acidulated sample is then placed on a special hot plate. Five samples are treated at a time. When the samples have come to a boil, No. 1 is lifted off and 12 cc. of the standard potassium permanganate solution is added from an automatic pipette and the sample replaced on a hot plate. The addition of the permanganate takes only a small fraction of a minute. One minute after No. 1 has been treated with permanganate solution No. 2 is treated; one minute after No. 2, No. 3, and so on until at the end of four minutes all five samples have been treated with the permanganate solution. One minute after No. 5 has had permanganate added No. 1 will have been boiling for five minutes. No. 1 is then removed and 10 cc. of a standard solution of ammonium oxalate is added from an automatic

pipette and No. 1 is replaced on the hot plate. The remaining samples are treated similarly at one minute intervals until nine minutes from the time the first permanganate solution is added the five samples, each of which has been boiling for five minutes with permanganate, are decoloured and ready for the final titration with the standard permanganate solution. This is proceeded with immediately. The next five samples are warming up while the first five are being titrated.

Three methods of dissolved oxygen have been tried: (1) Winkler's method; (2) a field method outlined by Mr. James Miller, F.I.C., in the Journal of the Society of Chemical Industry, February 28, 1914 (this is a modification of the method of Linossiers published in the Journal of the Society of Chemical Industry, 1891, page 726); and (3) a colorimetric method worked out by Mr. Lancaster and Mr. Bonham of the Provincial Board of Health, Ontario, which is a modification of a method outlined by Sir William Ramsay and Miss Homfray (Colorimetric Determination of Dissolved Oxygen), Journal, Society of Chemical Industry (1901), 20, 1071-4.

For determinative analysis the latter is undoubtedly the most accurate method yet outlined, but for turbid and coloured samples and for use in field work Miller's method is best. This being the case, Miller's method is the most suitable for general use and our technique for this method will be detailed later.

COLORIMETRIC STANDARDS FOR AMMONIA.

Permanent standards for ammonia are made up of an alkaline methyl orange solution instead of the platinum cobalt standards recommended by the American Public Health Association. They appear to be quite as satisfactory as the platinum standards. After standing for several months, however, a white solid may appear; this necessitates the renewal of the standards.

COLORIMETRIC STANDARDS FOR NITRITES

Permanent standards for nitrites are made up of solution of fuchsin, the desired bluish tone being secured by the addition of a solution of copper sulphate.

Nitrates.—If estimating nitrates in samples with a high chlorine content (by the phenol sulphonic method), make up standard, adding sufficient standard sodium chloride solution to make the chlorine content in the standard the same as in the sample. This renders the precipitation of the chlorine in the solution unnecessary and will give results sufficiently accurate for most purposes. Addition of Ammonium Hydroxide to the acid mixture instead of Potassium Hydroxide solution as recommended by the American Public Health Association, does away with the turbidity sometimes encountered in doing nitrates on sewage samples.

A. V. DeLaporte.

METHODS FOR WATER AND SEWAGE ANALYSIS.

COLLECTION OF SAMPLES.

For the physical, chemical and microscopical examination of water, bottles should be glass stoppered and have a capacity of at least two litres. Before using, the bottle should be cleansed by treating with sulphuric acid and potassium bichromate, rinsing with distilled water until the rinse water shows on testing with Barium Chloride solution, no trace of sulphates, then draining. The stoppers and necks of the bottles should be protected from dirt by tying cloth, sheet rubber, tin foil or oiled paper over them.

The time that may be allowed to elapse between the examination of a sample and its collection depends on the character of the sample and on the examination to be made.

The maximum limits suggested by the American Public Health Association are satisfactory.

Physical and Chemical Analysis.

	Hours.
Ground waters	72
Fairly pure surface waters	48
Polluted surface waters	12
Sewage effluents	6
Raw sewages	6

Microscopical Examinations.

	Hours.
Ground water	72
Fairly pure surface waters	24
Water containing fragile organisms. Immediate examination.	

Biological Examination.

	Hours.
Samples kept at less than 10 deg. C.	24

Samples for sanitary chemical examinations may be sterilized by the addition of chloroform, formaldehyde, mercuric chloride, which will permit of their being kept for longer periods than those indicated. The period of time elapsing between the collection of sample and its examination should be reported with the results.

Estimations of gases dissolved in samples, more especially oxygen, hydrogen sulphide and carbon dioxide must be at the time of collection of the sample in order to secure reasonable accuracy.

It is absolutely essential that the samples examined be truly representative, and it must not be forgotten that composite samples obtained by mixing amounts collected at frequent intervals over twenty-four hours may not indicate actual conditions but only an average which may be the result of wide variation.

ALUMINIUM CREAM.

This is used for clarification of samples in which colour or turbidity interferes with the determination of chloride, nitrites or nitrates.

Preparation.—Weigh out about 125 grams of potash or ammonium alum, dissolve in a small volume of distilled water, then dilute to about one litre in a large beaker. Add ammonium hydroxide until precipitation is complete; then wash by decantation until the wash water comes out free from nitrites and chlorides. Finally, make up to about a litre with distilled water, bottle and keep for use.

Application.—To apply this in clarification, rinse a 250 cc. flask with the sample, measure into it 200 cc. of the water to be examined, add 3 cc. aluminium cream, and shake vigourously. Allow to stand in a warm place for ten to fifteen minutes, then dilute to the mark with distilled water, and filter through a dry folded filter. Examine the filtrate in the ordinary way. Results must be multiplied by a factor to correct for the dilution.

TURBIDITY.

Use diatomaceous earth as free as possible from sponge spicules and amorphous silica. Wash with water to remove soluble salts; dry, and ignite to remove organic matter; treat and warm with dilute hydrochloric acid; wash with distilled water until free of acid, and dry thoroughly. Grind in an agate mortar, sifting through a No. 200 mesh sieve in order to separate mats obtained by grinding, and dry in a desiccator. One gram of this preparation in one litre of distilled water makes a stock suspension which contains 1,000 parts per 1,000,000 of silica, and which should have a turbidity of 1,000. Test this suspension, after diluting a portion of it with nine times its volume of distilled water, with a wire to ascertain if the silica has the necessary degree of fineness, and if the suspension has the necessary degree of turbidity. If not, correct by adding more silica or more water as the case demands. Standards for comparison shall be prepared from this stock suspension by dilution with distilled water. For turbidity readings below 20, standards of 0, 5, 10, 15 and 20 shall be kept in gallon bottles made of clear white glass; for readings above 20, standards of 20, 30, 40, 50, 60, 70, 80, 90 and 100 shall be kept in Nessler tubes, approximately twenty millimeters in diameter.

Comparison of the water under examination with standards shall be made by viewing them sidewise toward the light, looking at some object and noting the distinctness with which the margins of the object can be seen. The standards shall be kept stoppered, and both sample and standards shall be thoroughly shaken before making the comparisons.

In order to prevent any bacterial or algal growths from appearing in the standards, a small amount of bichloride of mercury may be added to them.

Notes:—

In readings higher than 100 use dilutions.

DETERMINATION OF COLOUR.

Solutions Required—

Platinum—Cobalt Standard.

Weigh out accurately 1.246 grams Potassium Platinic Chloride ($PtCl_4$ $2KCl$) and 1 gram Cobalt Chloride ($CoCl_2H_2O$), add 100 cc. concentrated hydrochloric acid, and dilute with distilled water to one litre in a standard flask. This solution has a colour of 500. By diluting various amounts of this solution with water to definite volumes in Nessler tubes, colours 0, 5, 10, 15—70 may be prepared. They are permanent if protected from dust.

Fill a Nessler tube to the graduation mark with the water to be examined to a depth equal to that of the standards. Compare with the standards by looking vertically downwards through the tubes upon a white surface placed at such an angle that the light is reflected upwards through the liquid. Dilute any samples having a colour greater than 70, before making the comparison.

The apparent colour is determined on the original sample without filtration. In the case of samples carrying suspended solids, the true colour is determined on the sample after filtration through paper, or if the suspended matter is fine, through a Berkefeld filter.

The results of colour determined shall be expressed in whole numbers and recorded.

Between	1 — 50	to the	nearest	unit.
	51 — 100	"	"	5
	101 — 250	"	"	10
	251 — 500	"	"	20

The method used by the United States Geological Survey gives results in substantial agreement with those obtained by the Platinum Cobalt method and is recognized as a standard procedure.

Notes:—

DETERMINATION OF ODOUR.

(1) When Cold.—When the bottle containing the sample has been standing at room temperature for some time, is about half full, give it a thorough shaking, remove the stopper and smell the odour at the mouth of the bottle.

(2) When Hot.—Pour about 150 cc. of the sample into a tall 400 cc. beaker without lip. Cover with a well-fitting clock glass, place on the hot plate and heat until the water is just below boiling point. Remove the beaker from the plate and allow to cool for not more than five minutes. Then shake with a rotary movement, slip the cover glass to one side and smell the odour.

Expression of Results.

QUALITY OF ODOUR.

A—Aromatic.	m—Mouldy.
C—Free chlorine.	M—Musty.
d—Disagreeable.	P—Peaty.
e—Earthy.	s—Sweetish.
f—Fishy.	S—Hydrogen sulphide.
g—Grassy.	V—Vegetable.

The intensity of the odour is expressed by prefixing a numeral to the expression of quality.

Numerical Value.	Term.
0	None.
1	Very faint.
2	Faint.
3	Distinct.
4	Decided.
5	Very strong.

Notes:—

ESTIMATION OF NITROGEN.

A. As Ammonia. I. Free Ammonia.

Reagents Required.

(a) *Ammonia Free Water.*

When the tap water is ordinarily pure; ammonia free water may be prepared from it by fractionating the distillate from the large still. If about thirty litres of tap water are placed in the still and ten litres collected in jar, the next ten litres which come over are practically ammonia free, and are best collected in glass stoppered bottles. Always apply test on 50 cc. with Nessler's reagent to make sure that no colouration is formed.

If for any reason the tap water carries an abnormal amount of organic matter it may be quite impossible to get ammonia free water in this way. In such cases a double distillation is necessary. Collect 5-10 litres of the best water from the still. Place it in a large round-bottom flask, add a few beads to prevent bumping and about 100 cc. of ammonia free sodium carbonate solution. Connect with glass condenser and distill again. After about one litre has passed over, test the distillate with Nessler's reagent, and if not free from ammonia continue the distillation and test again for ammonia. As soon as it is found to be ammonia free collect in the bottles prepared for the ammonia free water. Discontinue the distillation before the liquid in the flask has nearly boiled off.

(b) *Ignited Pumice to Prevent Bumping.*

Coarsely granular pumice may be ignited at red heat 5-10 minutes and then allowed to cool and placed in glass stoppered bottle. Avoid handling.

(c) *Nessler's Reagent.*

PREPARATION.

(*a*) Dissolve about 125 grams of potassium iodide crystals in 500 c.c. distilled water.
(*b*) Prepare a solution of mercuric chloride, saturated at ordinary temperature.
(*c*) Weigh out approximately 300 grams stick potash and dissolve in a small volume of water in a porcelain dish.

Reserve 20 cc. A, and to the remainder add B gradually, with constant stirring until a faint but permanent precipitate is formed. Then add the 20 cc. A, and again add B carefully, drop by drop, with constant stirring until a faint red opalesence persists. Add C gradually, then dilute the whole to two litres. Allow to settle and draw off the clear liquid into a small bottle for use as required.

(d) *Ammonia Free Sodium Carbonate Solution.*

Weigh out approximately 100 grams sodium carbonate, dissolve in one litre distilled water, and boil the solution until 3 cc. of it diluted to 50 cc. with ammonia free water give no reaction with Nessler's reagent. Cool and bottle.

(e) *Ammonium Chloride.* (*Standard Solution.*)

Weigh out accurately 3.82 grams of pure ammonium chloride, dissolve in distilled water and dilute to one litre. Mix thoroughly, then withdraw 10 cc. of this solution by means of a pipette, and dilute to one litre with distilled water preferably ammonia free.

1 cc. equivalent to 0.01 mg. nitrogen.

Analysis.

Thoroughly cleanse still. Rinse the flask with a few cubic centimeters HCl, then three times with tap water and three times with distilled water. Measure out about 500 cc. of distilled water (preferably ammonia free), transfer to flask, add two or three pieces of pumice, about 2 cc. ammonia free sodium carbonate solution, connect with the condenser and light the burner. Allow about 200 cc. to distill over. Then collect 50 cc. in Nessler tube and test with Nessler's reagent to make sure no ammonia is passing over. In Nesslerizing use plenty of rinse water for the tubes (if they have been standing rinse with HCl), followed by three rinsings of distilled and one of ammonia free water. Add about 2 cc. of Nessler's each time by means of a dip pipette and allow to stand five minutes before taking reading. Avoid touching with the rim of Nessler.

When the distillate has been found ammonia free, disconnect the flask and add 500 cc. of water sample (use standard flask to measure), reconnect the flask with condenser and continue the distillation, adjusting the burner so that 30 cc. of distillate pass over it in fifteen minutes. Collect four 50 cc. Nessler tubes and Nesslerize. The readings to be recorded as free ammonia, turn off the burner.

2. Albuminoid Ammonia.

Additional Reagent. *Preparation of Alkaline Permanganate Solution.*

Employ two 2-litre Erlenmeyer flasks, using each to make up one litre of solution, performing the following operations in duplicate.

Weigh out approximately 200 g. stick potash and eight grams crystallized potassium permanganate. Pour into the flask one litre of distilled water, and mark the level of the liquid with a blue pencil. Add 250 cc. distilled water and again mark the level reached by the water. Add the 200 g. potash cautiously, inclining the flask and sliding the sticks down the side. Shake the flask gently until the potash is all dissolved, then add the permanganate and boil briskly over a thin gauze, until the volume diminishes to 1,000 cc. Allow to cool and bottle. Use 30 cc. for each determination of albuminoid ammonia.

When distilling off the free ammonia for the above determination, prepare the solution of alkaline permanganate for addition to the distillation flask. Thoroughly cleanse a 400 cc. Erlenmeyer flask and measure into it 150 cc. ammonia free water. Add 25 cc. alkaline permanganate solution and boil briskly while the determination of free ammonia is being made. Add the contents of the Erlenmeyer flask to the distillation flask while still hot and distill over four more Nessler (50 cc.) tubes.

Nesslerize and record readings as albuminoid ammonia.

Standards.

The standard solution of ammonia chloride employed for comparison contains 0.01 mg. nitrogen per cubic centimeter. As the intensity of the colour produced by Nessler's reagent reaches maximum in about five minutes after reagent is added and remains practically constant for twelve hours, a set of standards may be made up for each day's work. In case the permanent standards recommended by the American Public Health Association are made from a solution of Cobalt chloride and potassium platinic chloride, they should be checked up by the standard ammonium chloride solution for each batch of Nessler, by each individual using them.

CALCULATION OF RESULTS IN P.P.M.

A Typical Calculation.

Laboratory No.	Free Ammonia using 500 c.c. water.
First tube	2.5
Second "	1.75
Third "	1.
Fourth "	0.
	5.25 x 0.02=parts per million.

Albuminoid ammonia is calculated in the same way.

SEWAGE.

For sewage the method in general is very much the same. It is necessary to use a smaller amount of sample; ordinarily 10 cc. is sufficient.

In charging the distillation flask for the cleansing of the still, use 720 cc. distilled water, 2 cc. of ammonium corbonate solution and a few pieces ignited pumice. This will ordinarily leave a sufficient amount of ammonia free water in the still to dilute the sewage to a volume great enough to supply 400 cc. distillate. If it is found that less than 500 cc. of water remain in the flask when sample is added, the contents may be diluted to approximately that amount with ammonia free water.

Notes:—

B. ESTIMATION OF NITROGEN AS NITRITES.

Solutions Required.

(a) *Sulphanilic Acid.*

Weigh out approximately 1.65 grams sulphanilic acid, transfer to a beaker, add 375 cc. distilled water and heat until the crystals are dissolved. Cool and add 125 cc. acetic acid (95%).

(b) *Alpha Naphthylamine Acetate.*

Weigh out about 0.25 grams alpha naphthylamine, transfer to a 200 cc. Erlenmeyer flask, add 50 cc. distilled water and boil in the fume cupboard for about five minutes, adding water as required to replace loss by evaporation. Filter through washed absorbent cotton. To the filtrate add 125 cc. acetic acid (95%), and dilute to 500 cc. with distilled water.

(c) *Standard Solution of Sodium Nitrite.*

1. If sodium nitrite can be obtained in a fair degree of purity, dry some of the salt by heating on a watch glass to constant weight in a steam oven. Weigh out accurately 0.246 grams of the dry salt, dissolve in distilled water to 500 cc. This solution contains 0.1 mg. nitrogen per cubic centimeter and will keep best in a cool, dark place. For use withdraw 10 cc. of the above solution (c. 1).

2. By means of a pipette, transfer to a litre flask, dilute to the graduation mark with distilled water.

1 cc. = 0.001 mg. nitrogen.

If the sodium nitrite in stock is known to be impure, prepare pure silver nitrite by adding silver nitrite solution to a concentrated solution of potassium nitrite, and allowing the silver nitrite which is sparingly soluble, to crystalize out. Recrystallize from aqueous solution, dry rapidly on paper and preserve in a brown kettle.

Weigh out accurately 0.22 grams of this silver nitrite, dissolve in distilled water, add sufficient dilute solution of pure sodium chloride to precipitate the silver completely. Mix until homogenous, transfer to a 200 cc. flask and dilute to the graduation mark with distilled water. Allow the precipitate to settle, then pipette out 10 cc. of the clear solution and dilute with distilled water to one litre.

1 cc. = 0.001 mg. nitrogen.

Analysis.

Rinse a 100 cc. Nessler tube with some of the sample, then fill to the graduation mark with the water to be examined. Add 2 cc. alpha naphthylamine acetate solution, 2 cc. sulphanilic acid solution and allow to stand ten minutes. Match the colour produced in similar tubes with distilled water, same amounts of reagents, and known quantities of the sodium nitrite solution added from burette. If the sample is turbid or coloured, clarify with aluminium cream. Nitrites are present in the air of a room in which gas is burning. If such a laboratory is used do not allow the tube to stand more than thirty minutes after adding the reagent.

C. Estimation of Nitrogen as Nitrates.

Solutions required.

(*a*) *Standard solution of potassium nitrate.*

Weigh out accurately 0.720 grams pure potassium nitrate. Dissolve in a small tube of water, then dilute to one litre with distilled water.

(*b*) *Phenol-disulphonic acid.*

Weigh out about 15 grams pure phenol, transfer to a 200 c.c. Erlenmeyer flask, add 100 c.c. pure concentrated sulphuric acid and heat on the water bath for six hours.

(*c*) *Colorimetric standard solution.*

By means of a pipette, measure out 10 c.c. of the standard solution of potassium nitrate, (solution 1 above), evaporate to dryness in a small porcelain dish, moisten quickly and thoroughly with 2 c.c. of the phenol-disulphonic acid solution and dilute to one litre with distilled water.

1 c.c. of the solution = 0.001 mg. nitrogen.

Analysis.

If the sample is coloured or shows turbidity, clarify with aluminium cream. Clear, colourless samples may be examined without preliminary treatment. By means of a pipette, measure out 10 c.c. sample into a 3-inch evaporating dish, and heat on the water bath until only a few drops remain, then set aside and allow the remainder to evaporate spontaneously.

Add six drops of phenol-disulphonic acid directly upon the dry residue, and stir with a glass rod to mix thoroughly. Dilute with about 10 c.c. distilled water, then add 10 c.c. ammonium hydroxide. Rinse the solution into a 50 c.c. Nessler tube, and dilute to the graduation mark with distilled water.

Match the colour produced in similar tubes by adding from a burette, various amounts to the standard colorimetric solution (3) to distilled water made alkaline with ammonium hydroxide. Chlorides interfere with the accuracy of the method, but not seriously, unless the chlorine is greater than 20 parts per million.

In examining samples high in chlorides, add to the standard solution of potassium nitrate, the amount of standard solution of sodium chloride required to increase the chloride content to equal that of the sample.

If pure silver sulphate free from nitrates is obtainable it may be employed to precipitate the chlorine. Pipette out 10 c.c. of the sample and add N/50 sulphuric acid to not quite neutralize the alkalinity (determined previously as temporary hardness by titration with lacmoid as indicator). Add sufficient silver sulphate solution (4.3969 grams per litre; 1 c.c. = 1 mg.) to precipitate the chlorides. Heat to boiling, add a little aluminium cream, allow to settle and filter while hot. Wash with small amounts of hot distilled water. Examine the filtrate in the ordinary way.

ORGANIC NITROGEN.

Procedure for Water: Boil 500 cc. of the sample in a round-bottomed flask to remove ammonia nitrogen. This usually causes the loss of 200 cc. of the sample, which may be collected for the determination of ammonia nitrogen. Add 5 cc. of nitrogen-free concentrated sulphuric acid and a small piece of ignited pumice. Mix by shaking and place over a flame under a hood. Digest until copious fumes of sulphuric acid are given off and the liquid finally becomes colorless or pale straw color. Remove from the flame, and add potassium permanganate crystals in small portions until a heavy green precipitate persists in the liquid. Cool. Dilute to about 300 cc. with ammonia-free water. Make alkaline with 10 per cent. ammonia-free sodium hydroxide. Distill the ammonia, collect the distillate in Nessler tubes, Nesslerize, and compare with standards as described for the estimation of Ammoniacal Nitrogen.

Procedure for Sewage: Distill the ammonia nitrogen directly from 100 cc. or less of the sample, diluted to 500 cc. with nitrogen-free water. Collect the distillate and determine the ammonia nitrogen in it. Add 5 cc. of nitrogen-free sulphuric acid and 1 cc. of 10 per cent. nitrogen-free copper sulphate, and digest the liquid for half an hour after it has become colorless or pale straw color. Add 5.0 gram of potassium permanganate crystals to the hot acid solution, and dilute to 500 cc. with ammonia-free water. Dilute 10 cc. or more of this liquid, in a Kjeldahl distilling flask, to about 300 cc. with ammonia-free water. Make alkaline with 10 per cent. sodium hydroxide, distill, and Nesslerize. With some samples direct Nesslerization may be used.

In this determination care must be taken to digest thoroughly, to add potassium permanganate to the point of precipitation, to sample carefully after dilution, and to add enough sodium hydroxide to insure the separation of the ammonia from the precipitated manganese hydroxide. Potassium permanganate should not be added during digestion because it causes loss of nitrogen.

TOTAL NITROGEN.

The total nitrogen is calculated by adding together the Organic, nitrite, nitrate and ammonia nitrogen.

Notes:—

TOTAL RESIDUE.

Evaporate 100 cc. of the thoroughly shaken sample in a tared paltinum dish on a water bath. Dry the dish in a drying oven at 103°C. for one hour. Cool in a desiccator and weigh. Multiply the weight of the residue in milligrams by ten to secure the result in parts per million.

FIXED RESIDUE AND LOSS ON IGNITION.

Ignite the above residue in the platinum dish at dull red heat, until the residue is white or nearly so. Cool and just moisten with water. Dry the residue in an oven as for total solids and weigh. Record the weight of the final residue as fixed solids and the difference between the weight of the fixed solids and total solids is recorded as loss on ignition.

SUSPENDED SOLIDS.

The difference between the total solids in filtered and unfiltered portions of the sample is used as a basis for calculating suspended matter.

Notes:—

OXYGEN CONSUMED.

Reagents required.

(*a*) *Dilute Sulphuric Acid.*

One part strong acid to three parts distilled water, 10 cc. approximately used in each titration.

(*b*) *Solution of Ammonium Oxalate.*

0.888 grams crystals dissolved in small amount of distilled water, and the solution made up to one litre. 1 cc. is equivalent to 0.1 mg. of oxygen.

(*c*) *Standard Solution of Potassium Permanganate.*

0.3952 g. of the salt, dissolved in small vol. distilled water, then made up to 1 litre. 1 cc. = 0.1 mg. available oxygen.

Analysis.

Measure 100 cc. of the water sample (10 cc.-50 cc. in case of sewage) into a porcelain dish by means of a pipette, add 10 cc. of sulphuric acid solution, and in case of sewage dilute to 100 cc. Heat to boiling, read permanganate burette, then add 12 cc. of the standard permanganate solution. Raise the burette from the steam, and continue to heat the dish over the open flame. At the end of five minutes, remove the flame, add 10 cc. ammonium oxalate solution by means of a pipette, and then add permanganate gradually, until a permanent pink coloration appears. Read the burette.

The permanganate solution is used up by

(1) The organic impurities in the sample.

(2) The ammonium oxalate added.

Make a "blank" determination, using 100 cc. distilled water instead of the sample in the above. The amount of permanganate required in this will represent the amount equivalent to the 10 cc. ammonium oxalate under the conditions of time, temperature and concentration observed in the process.

The difference between the two amounts of permanganate will represent the amount consumed by the organic impurities in the sample. Certain other materials, such as hydrogen sulphide, nitrites and chlorides affect the result, but not seriously except when present in large amounts, and may be disregarded unless for special reasons extreme accuracy is desired.

DISSOLVED OXYGEN—"MILLER'S METHOD."

Reagents.

(*a*) *Methylene Blue Solution*—1 gram of methylene blue is dissolved on 1000 cc. of distilled water.

(*b*) *Ferrous Ammonium Sulphate Solution*—0.3103 grams of ferrous ammonium sulphate and 1 cc. concentrated sulphuric acid made up to 100 cc.

(*c*) *Alkaline Tartrate Solution*—60 grams of caustic soda and 173 grams of sodium potassium tartrate (Rochelle salt) dissolved in 500 cc. of water.

Analysis—50 cc. of the sample to be tested are pipetted into 100 cc. Nessler tube—being introduced below a covering layer of paraffin oil; 5 cc. of solution (*c*) and 1 drop of solution (*a*) are then added. Then from a 10 cc. graduated pipette solution (*b*) is run just below the surface of the liquid, stirring gently with a pipette until the colour is just discharged. The pipette reading gives the number of cubic centimetres of oxygen per litre.

Theoretically 1 cc. of (*b*) does not equal 1 cc. of oxygen per litre working on 50 cc. of the sample, but the above strength gives approximately correct results.

Miller says: "Each laboratory worker should test his ferrous sulphate against water of known oxygen content, say distilled water shaken with air until saturated, taking the temperature and referring to Roswe & Lint's table (Sutton's volumetric analysis, page 260) for the amount of dissolved oxygen present."

Notes:—

DETERMINATION OF HARDNESS.

Temporary Hardness.

Standard solutions required:—

(*a*) *Lacmoid solution for indicator.*

Dissolve one-half gram of lacmoid, in 500 cc. of 50 per cent. alcohol. Keep in bottle with dropping tube inserted through the cork.

(*b*) *N/50 sulphuric acid solution.*

Dilute 20 cc. of normal solution of sulphuric acid measured by means of a burette or calibrated pipette to 1 litre with distilled water. The normal sulphuric acid is best prepared by diluting concentrated sulphuric acid to the approximate strength standardizing by precipitation with barium chloride and weighing the barium sulphate obtained. From the results of this approximate standardization the amount of water necessary to add in order to bring the solution to exactly normal strength may be calculated.

Analysis.

For the determination of temporary hardness of a water sample, measure out 100 cc. by means of a pipette, transfer to a porcelain dish or casserole, add ½ cc. of lacmoid solution and run in N/50 sulphuric acid solution from a burette until the blue colour has changed to a reddish purple, then heat rapidly to incipient boiling, remove the flame and continue the addition of the standard acid until a drop added causes no change in the reddish purple colour of the solution.

From the amount of sulphuric acid used calculate the temporary hardness of the sample. One cc. of N/50 sulphuric acid is equivalent to one milligram of calcium carbonate.

Total Hardness (soap consuming power).

This determination must be carried out at 20° C.

Solutions required:

(*a*) *Standard solution of calcium chloride.*

Weigh out accurately 1 gram of C.P. calcium carbonate, transfer to a porcelain dish, cover with a clock glass and add gradually through the lip of the dish dilute hydrochloric acid in sufficient quantity to dissolve the carbonate. Remove cover glass, rinse with distilled water, and evaporate to dryness on a water-bath. Add about 25 cc. of distilled water and evaporate once more, then dilute to one litre with distilled water. Each cc. of this solution is equivalent to one milligram of calcium carbonate.

(*b*) *Standard soap solution.*

Scrape about ten grams of shavings from a bar of pure white castile soap, dissolve them in one litre of approximately 60 per cent. alcohol. If not clear, filter through paper.

Standardization of the Soap Solution—Measure out by means of a pipette 10 cc. of the standard calcium chloride solution, transfer to a 150 cc. glass-stoppered bottle and add 90 cc. of distilled water. Add gradually from a burette the standard soap solution until a permanent flame is obtained upon shaking. At first the soap solution must not be added in quantities greater than 1 cc. After each addition shake for a quarter of a minute and place the bottle on its side until the lather formed has broken. Towards the end of the titration do not add more than 1/10 of a cc. of the soap solution each addition, and the end point is taken as the point at which a permanent lather persists for five minutes with the bottle lying on its side. From the result of the titration, calculate the amount of calcium carbonate equivalent to 1 cc. of the standard soap solution.

In doing this it is necessary to allow for the soap consumed by the distilled water. Make a blank determination the same as the above, only using 100 cc. of distilled water with no calcium chloride solution. Deduct the amount required from that previously determined in the standardization.

Analysis.

If the determination of temporary hardness has shown the water to contain much calcium carbonate (more than 200 parts per million) measure out 50 cc. of the sample, transfer to the glass-stoppered bottle, dilute with 50 cc. distilled water and add standard soap solution gradually, shaking after each addition until a lather is formed which persists for five minutes. Deduct from the amount of soap solution used the quantity equivalent to the 50 cc. of distilled water. Express the results in parts of calcium carbonate per million. If the water does not appear to be very hard in the titration with N/50 sulphuric acid, use 100 cc. of the sample in the titration with standard soap solution.

ALKALINITY.

Reagents:

(*a*) *N/50 sulphuric acid.*

(*b*) *Phenolphthalein*—0.5 grams in 50 per cent. alcohol. Neutralize with N/50 KOH solution. Dilute the alcohol with boiled distilled water.

(*c*) *Methyl Orange*—Dissolve 0.5 grams in a litre of distilled water, keep in the dark.

(*d*) *Lacmoid*—Dissolve 2.0 grams of lacmoid in 1 litre of 50 per cent. alcohol as for phenolphthalein.

(*e*) *Erythrosine*—Dissolve 0.5 grams of erythrosine (sodium salt) in a litre of freshly-boiled distilled water.

PHENOLPHTHALEIN.

Add 4 drops of phenolphthalein indicator to 50 cc. or 100 cc. of the sample in a white porcelain casserole or an Erlenmeyer flask over a white surface. If the solution becomes coloured, hydroxide or normal carbonate is present. Titrate with N/50 H_2SO_4. The phenolphthalein alkalinity in parts per million of $CaCO_3$ is equal to the number of cc. of N/50 H_2SO_4 used, multiplied by 20 if 50 cc. of the sample was used or by 10 if 100 cc. was used. This alkalinity is due to hydroxides and normal carbonate.

PROCEDURE WITH METHYL ORANGE.

Proceed with titration as before, using two drops of methyl orange indicator. Calculate the methyl orange alkalinity in the same manner as the phenolphthalein alkalinity. This is due to normal carbonate and bicarbonate alkalinity.

LACMOID.

Add four drops of lacmoid and proceed as before until within 1 or 2 cc. of the amount necessary for neutralization has been added. Warm the solution until it just begins to boil and then continue the titration until a drop of the acid striking the surface of the liquid produces no change in the uniform reddish or purple colour of the solution. Calculate as before.

ERYTHROSINE.

Add 5 cc. of neutral chloroform and 1 cc. of erythrosine to 50 or 100 cc. of the sample in a 250 cc. clear glass-stoppered bottle. If the chloroform becomes rose coloured on shaking, hydroxide, bicarbonate or normal carbonate is present. Add N/50 sulphuric acid from a burette until chloroform is colourless. Calculate as before.

CALCULATION FOR BICARBONATE.

Bicarbonate is present if the alkalinity to phenolphthalein is less than half the alkalinity to methyl orange, erythrosine, or lacmoid. The alkalinity to methyl orange, erythrosine, or lacmoid is due entirely to bicarbonate, if there is no phenolphthalein alkalinity. If there is phenolphthalein alkalinity, the bicarbonate, in terms of $CaCO_3$ is equal to methyl orange, erythrosine or lacmoid alkalinity minus twice phenolphthalein alkalinity. Biearbonate $(HCO_3)=1.22$ times the bicarbonate expressed in terms of $CaCO_3$. Carbon dioxide=0.88 times bicarbonate expressed as $CaCo_3$. Half bound earbon dioxide=0.44 time bicarbonate expressed as $CaCo_3$.

CALCULATION FOR NORMAL CARBONATE.

Normal carbonate is present if the alkalinity to phenolphthalein is greater than zero but less than the alkalinity to methyl orange, erythrosine or lacmoid. If the phenolphthalein alkalinity is exaetly equal to half methyl orange, erythrosine or lacmoid, the alkalinity is due entirely to normal earbonate. If phenolphthalein alkalinity is less than half methyl orange, erythrosine, or lacmoid alkalinity, normal earbonate expressed in terms of $CaCo_3$ is equal to twice phenolphthalein alkalinity. If phenolphthalein alkalinity is greater than half methyl orange, erythrosine or lacmoid alkalinity normal earbonate equals twice the difference between methyl orange, erythrosine or laemoid alkalinity and the phenolphthalein alkalinity.

Carbonate (Co_3) = 0.6 times the normal carbonate expressed as $CaCo_3$.

Bound Carbon dioxide = sum of Carbon dioxide as earbonate and one-half Carbon dioxide as bicarbonate.

CALCULATION FOR HYDROXIDE.

If hydroxide is present the alkalinity to phenolphthalein is greater than one-half alkalinity to methyl orange, erythrosine or lacmoid. Alkalinity is due entirely to hydroxide if phenolphthalein alkalinity is equal to methyl orange, erythrosine, or lacmoid alkalinity.

If phenolphthalein alkalinity is more than one-half and less than all methyl orange, erythrosine or lacmoid alkalinity, hydroxide expressed in terms of $CaCo_3$, is equal to twice the phenolphthalein alkalinity minus the methyl orange, erythrosine, or lacmoid alkalinity.

ALKALI CARBONATES.

Determine total alkalinity by titration with N/50 sulphuric acid, using methyl orange, erythrosine, or lacmoid as indicator. Then determine calcium and magnesium content, and subtract from total alkalinity the computed alkalinity due to calcium and magnesium expressed in terms of $CaCo_3$. The remainder is alkalinity due to earbonates and biearbonates of sodium and potassium.

ACIDITY.

Reagents.

(*a*) *N/50 sodium carbonate.*

Dissolve 1.06 grams of anhydrous sodium carbonate in 1 litre of boiled distilled water that has been cooled in atmosphere free from Carbon dioxide.

Preserve the solution in resistant glass bottles protected from air by tubes filled with soda lime.

1 c.c. is equivalent to 1.0 mg. $CaCo_3$.

(*b*) *N/22 sodium carbonate.*

Dissolve 2.41 grams of anhydrous sodium carbonate in 1 litre boiled distilled water as in (1).

1 c.c. = 1mg. $CaCo_3$.

(*c*) *Phenolphthalein indicator,* see under alkalinity.

(*d*) *Methyl orange indicator,* see under alkalinity.

TOTAL ACIDITY.

Add 4 drops phenolphthalein to 50 c.c. or 100 c.c. sample in white porcelain casserole or Erlenmeyer flask over a white surface. Add N/50 Sodium carbonate until solution turns pink.

Total acidity in parts per million of $CaCo_3$ is equal to the number of c.c. of N/50 Sodium carbonate used, multiplied by 20 if 50 c.c. sample was used, or by 10 if 100 c.c. was used.

FREE CARBON DIOXIDE.

Carbon dioxide may exist in water in three forms—free carbon dioxide, bicarbonate, and carbonate.

One half the carbon dioxide as bicarbonate is known as the half-bound carbon dioxide. The carbon dioxide as corbonate plus one-half that as bicarbonate is known as the bound carbon dioxide.

Pour 100 c.c. of sample into a tall narrow vessel, preferably 100 c.c. Nessler tube. Add 10 drops phenolphthalein, and titrate rapidly with N/22 Sodium carbonate, stirring gently until a faint but permanent pink colour is produced.

The free carbon dioxide in parts per million is equal to 10 times the number of c.c. of N/22 Sodium carbonate used.

If possible a special sample should be collected for this determination, which should preferably be made at the time of collection.

If analysis cannot be made at once, sample bottles should be completely filled with water, so as to leave no air spaces under stopper.

Bottled samples should be kept until tested at a lower temperature than that of water when collected.

FREE MINERAL ACIDS.

Add 2 drops methyl orange indicator to 50 cc. or 100 cc. sample in white porcelain dish or an Erlenmeyer flask over a white surface. Add N/50 Sodium carbonate from a burette until pink color of solution disappears. Acidity due to free mineral acids expressed as $CaCo_3$ is equal to number of ccs. of N/50 Sodium carbonate, multiplied by 20 if 50 cc. sample was used, or by 10 if 100 cc. was used.

MINERAL ACIDS AND SULPHATE OF IRON AND ALUMINUM.

Modify method for free mineral acids by titrating sample at boiling temperature in presence of phenolphthalein indicator.

The acidity due to free mineral acid and sulphate of iron and aluminum, expressed as $CaCo_3$, may be calculated as before.

The acidity due to sulphate of iron and aluminum is equal to acidity due to mineral acids and sulphate minus acidity due to mineral acids.

Report acidity in parts per million of $CaCo_3$, Sulphate (So_4) equals parts per million of $CaCo_3$ multiplied by 0.96.

DETERMINATION OF CHLORINE AS CHLORIDE.

Solutions required:—

(*a*) *Standard solution $AgNO_3$*

(*b*) *Standard solution NaC1*

(*c*) *K_2CrO_4 solution.*

NaC1. Weigh accurately 1.648 gms. pure NaC1 dissolved in distilled water and dilute to 1 litre. One cc. of this solution is equal to 1 mg C1.

$AgNO_3$. Dissolve about 2.40 gms. of $AgNO_3$ crystals in distilled water and dilute to one litre. One cc. of this solution contains Ag equivalent to approximately 0.0005 gms. C1.

K_2CrO_4. Dissolve 50 gms. neutral K_2CrO_4 in a little distilled water. Add enough $AgNO_3$ to produce slight red ppt. Filter and dilute to one litre with distilled water.

Analysis.

Measure out 10 cc. sewage sample or 100 cc. water sample into a porcelain dish or casserole, dilute to about 50 cc. for sewage. Add K_2CrO_4 solution sufficient to give a decided colour (3-5) drops. Run in standard $AgNO_3$ solution from a burette, with constant stirring, until the red colour due to $AgCrO_4$ appears. To assist the eye in detecting this colour change add at the end of the first titration sufficient NaC1 solution to discharge the red colour and keep the dish beside the similar one used in subsequent titrations. Ordinarily the $AgNO_3$ solution will be of such strength that 1 cc. will equal to 0.5 mgs. of C1. If necessary apply a correction factor obtained by standardizing the $AgNO_3$ solution by titration as above with the standard solution of NaC1.

NOTE.

This process is sufficiently accurate for most purposes. In cases where extreme accuracy is desired it is advisable to titrate in Nessler tubes, using a yellow light. If acid waters are to be examined, neutralization with Na_2Co_3 must precede the titration. In examining highly coloured waters preliminary clarification is necessary.

DETERMINATION OF IRON.

Solutions required:—

(*a*) *Standard Iron Solution.*

This solution is to be of such concentration that 1 cc. contains 0.1 mg. iron. It may be prepared by either of two methods.

(1) Weigh out accurately 0.7 grams pure ferros ammonium sulphate, dissolve in a small volume of distilled water. Add 20cc. 25 per cent. sulphuric acid. Warm and add dilute solution of potassium permanganate until the iron is just oxidized. Dilute with distilled water to 500cc.

(2) Weigh out accurately 0.86 grams ferric ammonium alum, dissolve in 500cc. distilled water, add 5cc. conc nitric acid and dilute to 1 litre.

(*b*) *Potassium Thiocyanate.*

Weigh out about 5 grams of the salt and dissolve in 500 cc. distilled water.

Analysis.

Into a 100 cc. Nessler tube, pour 4 cc. hydrochloric acid, 1 cc. nitric acid and 50 cc. of the sample. Add 5 cc. potassium thiocyanate solution dilute to the graduation mark with distilled water. If iron be present, a blood red coloration will be produced. To another similar Nessler tube add distilled water, the same amount of iron reagents as above, with sufficient of the standard solution of iron from a burette, to match the colour formed in the tube containing the sample. If the amount of standard required is greater than 3 cc. the sample must be diluted. This procedure will be found satisfactory in ordinary waters. If turbidity interferes evaporate 100 cc. of the sample of dryness in a porcelain dish on the water bath. When dry add 4 cc. hydrochloric acid, 1 cc. nitric acid and evaporate to dryness in the fume cupboard, add 50 cc. distilled water, filter into a 100 cc. Nessler tube, add 5 cc. potassium thiocyanate solution and dilute to the 100 cc. mark with distilled water. Compare with a standard made up from the standard iron solution, using the same amount of reagents.

Notes:—

DETERMINATION OF LEAD.

Solutions required:

(*a*) *Standard Solution of Lead.*

Weigh out accurately 1.464 grams pure lead sulphate, transfer to a 250 cc. beaker. Add a concentrated solution of ammonium acetate prepared by neutralizing concentrated acetic acid with ammonia, (Litmus). Cover with heat on the hot plate or gauze until dissolved. Cool rinse down with distilled water, and dilute to one litre in a standard flask.

1 cc.=0.001 g. Pb.

(*b*) *Hydrogen Sulphide Solution.*

Nearly fill a small glass-stoppered bottle with cold distilled water and pass hydrogen sulphide gas into it until saturation is reached. Keep stoppered in a cool place. This solution must be clear and freshly prepared.

For Colorless Samples. *Analysis.*

Measure 50 cc. sample into a Nessler tube, add two or three drops of acetic acid and 2 cc. hydrogen sulphide water. If a color is produced match the same with varying amounts of the standard solution of lead. Before reporting a negative result it is necessary to concentrate a litre of the water to small volume by boiling in a porcelain dish over the open flame.

For Colored Samples. *Analysis.*

Evaporate two litres of the sample to about 25 cc., add 10 cc. 10 per cent solution of ammonium chloride and ammonium hydroxide to make strongly alkaline. Then add hydrogen sulphide water and allow to stand for three hours. Boil to expel excess of hydrogen sulphide, and filter. Precipitates of iron, suspended organic matter, with copper and zinc may be present. Filter, wash once with hot water, transfer the filter paper and precipitates to the original dish and dissolve the sulphides by boiling with dilute nitric acid (1 part concentrated nitric acid, 5 parts water), filter and wash. Evaporate to 12-15 cc., cool, add 5 cc. concentrated sulphuric acid and heat on the hot plate in the fume cupboard until fumes of sulphuric acid are evolved. Then if the original samples contained less than 0.25 parts iron per million boil, filter and determine the lead in the filtrate, making the standards alkaline with ammonia. If the iron content exceeds 0.25 parts per million, wash the lead sulphate into a beaker, add alcohol and water and allow to settle over night. Filter, wash free from iron with 50 per cent. alcohol. Dissolve the precipitates by boiling with ammonium acetate, filter and determine the lead as before. Copper, if present in considerable quantity, will give a blue colour to the ammoniacal filtrate from the iron precipitate. A more delicate test employs the ferrocyanide reaction. To the ammoniacal filtrate add acetic acid until distinctly acid, then a few drops of potassium ferrocyanide solution. A red-brown precipitate indicates copper.

HYDROGEN SULPHIDE.

Reagents.

(*a*) *N/100 sodium thiosulphate.*
(*b*) *N/100 iodine solution.*
(*c*) *Starch solution.*
(*d*) *Potassium Iodide Crystals.*

Add 500 cc. of the sample to 10 cc. of the standard iodine solution and 1 gm. of potassium iodide in a glass-stoppered bottle. Shake the bottle and stand for a few minutes and then titrate the excess of iodine with the sodium thiosulphate solution, using the starch indicator. Hydrogen sulphide in parts per million is equal to 0.34 times the number of cubic centimetres of iodine solution used up by the sample.

CHLORINE.

To test for free chlorine in waters that have been treated calcium hypochlorite or liquid chlorine.

Mix 2 cc. of the potassium iodide solution used in the valuation of bleaching powder, 2 cc. of 95 per cent. acetic acid, 1 cc. of starch indicator in 100 cc. of the sample to be tested. A blue colour indicates the presence of free chlorine. The depth of the color is a rough indication of amount of chlorine.

Notes:—

MINERAL ANALYSIS OF WATER.

Analysis.

Evaporate 1 litre of the sample in a weighed platinum dish upon a water bath. When dry, transfer to an air bath and heat at 105° C. for 30 minutes. Cool and weigh. Then ignite slowly to a dull red heat until all carbonaceous matter is consumed. Cool and weigh. The loss is equal to the weight of the organic matter and the volatile matter. Warm the residue with 10-15 cc. HCl and 25 cc. H_2O. Boil and filter through an ashless filter into a 100 cc. graduated flask, wash the residue thoroughly with hot water and make up to the mark with H_2O.

(1) The residue SiO_2, Al_2O_3, $CaSO_4$.

Dry, ignite and weigh. Then fuse with Na_2CO_3 in a platinum crucible. Dissolve in H_2O made acid with HCl—evaporate to dryness, take up with H_2O and HCl and filter.

Ignite and weigh the residue, then add 2 drops concentrated H_2SO_4 and a little HFL. Volatilize the acids, ignite, weigh, report loss of weight as SiO_2.

Make the filtrate alkaline with NH_4OH, boil and filter. The precipitate is Al_2O_3 dry; ignite and weigh. To the filtrate add solution of $(H_4)_2$ C_2O_4. Set aside for 3 hours in a warm oven. Filter, dry, ignite and weigh as CaO.

(2) The Solution.

To the boiling solution add a few drops of HNO_3 and a little NH_4Cl solution, add NH_4OH cautiously until alkaline, boil and filter.

The precipitate is Al_2O_3, Fe_2O_3. Dry, ignite and weigh.

To the filtrate add $(NH_4)_2C_2O_4$ in slight excess, set aside for 3 hours in warm oven and filter. The precipitate is CaC_2O_4, wash, dry, ignite and weigh as CaO.

Evaporate the filtrate to dryness in a pt. dish and ignite to expel ammonium salts. Cool, add H_2O, boil, filter and wash well. The precipitate is HgOm HO. Dry, ignite and weigh as MgO. Transfer the filtrate to a weighed platinum dish, add a few drops H_2SO_4 and evaporate to dryness and ignite to constant weight. The residue consists of Na_2SO_4, $MgSO_4$, K_2SO_4. After weighing, dissolve in H_2O. Make the solution up to 50 cc. Mix thoroughly and divide into 2 equal portions of 25 ccs. each.

(*a*) To a portion of the above solution add a few drops of HCl, make alkaline with NH_4OH. Add with constant stirring a solution of HNa_2PO_4, set aside for 3 hours, filter, dry, ignite and weigh as $Mg_2P_2O_7$. Calculate this to $MgSO_4$ and after multiplying by 2 subtract from the weight of the alkalies above. Calculate the Mg as MgO.

(*b*) To the other portion of the solution add a few drops of HCl then a solution of $PtCl_4$ evaporate on a water bath with some alcohol. Filter off the K_2PtCl_6 on a small tared filter, dry and weigh. Calculate the weight to K_2SO_4 and after multiplying by 2 subtract from the weight of the sulphates above. The difference in weight after subtracting the K_2SO_4 and $MgSO_4$ is Na_2SO_4. Calculate the Na to Na_2O and K to K_2O.

(3) *SO_3*.

Take 500 c.c. of the original solution. Add 2 c.c. concentrate HC1 and evaporate on a water bath, in an open beaker to 150 c.c. Add a hot 10 per cent. solution of $BaC1_2$ until precipitation is complete. Warm for an hour on a hot water bath and allow to settle for at least three hours. Filter, dry, ignite and weigh as $BaSO_4$. Calculate to SO_3.

Notes:—

(4) CO_2. This is found by combining the C1 and SO_3 with the bases and then calculating the amount of CO_2 that would be required to convert the rest of the CaO and MgO into carbonates.

(5) Chlorine to be estimated as chlorine in chlorides.

Notes:—

BIOCHEMICAL OXYGEN DEMAND OF SEWAGE AND EFFLUENTS. RELATIVE STABILITY METHOD.

The relative stability method may be employed to obtain a measure of the putrescible material in sewages and effluents in terms of oxygen demand.

Procedure for Effluents: Divide the total available oxygen, including the oxygen of nitrite and nitrate by the relative stability expressed as a decimal.

Procedure for Sewages: Make one or two solutions with fully aerated distilled water of known dissolved oxygen content. Tap water may be employed if it is free from nitrates. Vary the relative proportions of sewage and water to be employed to give a relative stability of 50 to 75. Unless seals are used bring the water as well as the sewage to the temperature at which the mixtures are to be incubated before preparing the dilutions. During the manipulation avoid aeration. Having made the proper dilutions, determine the relative stability of each.

Calculate the oxygen demand in parts per million by the formula:

$$\text{Oxygen demand} = \frac{0\ (1\text{-}p)}{Rp}$$

In this formula, 0 is the initial dissolved oxygen of the diluting water, p is the proportion of sewage; and R is the relative stability of the mixture. Ordinarily the available oxygen in crude sewages, septic tank effluents, settling tank effluents, and trade wastes can be neglected.

RELATIVE STABILITY OF EFFLUENTS.

Reagent.—*Methylene blue solution.*

A 0.05 per cent. aqueous solution of methylene blue, preferably the double zinc salt or commercial variety.

Collect the sample in a glass-stoppered bottle holding approximately 150 cc. If the dissolved oxygen is low observe precautions similar to those used in collecting samples for dissolved oxygen.

Add 0.4 cc. of the methylene blue solution to the sample in the 150 cc. bottle. As methylene blue has a slightly antiseptic property be careful to add exactly 0.4 cc. Add the methylene blue solution preferably below the surface of the liquid after filling the bottle with the sample. If the methylene blue is added first do not allow the liquid to overflow as colouring matter will thus be lost. Incubate the sample at 20°C. for ten days. Four days' incubation may be considered sufficient for all practical purposes in routine plant-control work. If quick results are desired, incubate the sample at 37°C. for five days, using suitable stoppers to prevent the loss and reabsorption of dissolved oxygen. The bacterial flora at 37° C. is different from that at 20° C. The lower temperature is more nearly the average temperature of surface waters, and therefore the higher temperature should be used only when quick approximate results are essential. Observe the sample at least twice a day during incubation. Give a sample in which the methylene blue becomes decolourized, a relative stability corresponding to the time required for reduction (see Table). For routine filter control ordinary room or cellar temperature gives fairly satisfactory results. For accurate studies, room temperature incubation is very undesirable, as the fluctuations in temperature which are ordinarily not noticed are responsible for appreciable

deviations from the true values of relative stability. If the samples are incubated less than ten days at 20°C., and are not decolourized, place a plus sign after the stability value in order to indicate that the stability might have been higher if more time had been allowed. In applying this test to river waters it often happens that the blue colouring matter is removed either partly or completely through absorption by the clay which many rivers carry in suspension. True relative stabilities cannot be obtained for such waters except by determining the initial available oxygen at the start and bio-chemical oxygen demand on incubation at 20° C. for ten days. Germicides, such as hypochlorite of lime, if present, in sufficient quantity, vitiate the results. If a sample contains free chlorine, therefore, store it about two hours, or until the chlorine is gone, and then add methylene blue.

The Table gives the relation between the time in days to decolourize methylene blue at 20°C. and the relative stability number of ratio of available oxygen to oxygen required for equilibrium, expressed in percentage.

RELATIVE STABILITY NUMBERS.

Time required for decolorization at 20°c.	Relative Stability.	Time required for decolorization at 20°c.	Relative Stability.
Days	Percentage	Days	Percentage
0.5	11	8.0	84
1.0	21	9.0	87
1.5	30	10.0	90
2.0	37	11.0	92
2.5	44	12.0	94
3.0	50	13.0	95
4.0	60	14.0	96
5.0	68	16.0	97
6.0	75	18.0	98
7.0	80	20.0	99

The theoretical relation is, S=100 (1-0.794t20). The relation between the time of reduction at 20°C. and that at 37°C. is approximately two to one, but if an observer incubates at 37°C. he should work out his own comparative 37°C. table or factor.

A relative stability of 75 signifies that the sample examined contains a supply of available oxygen equal to 75 per cent. of the amount of oxygen which it requires in order to become perfectly stable. The available oxygen is approximately equivalent to the dissolved oxygen plus the available oxygen of nitrate and nitrite. Nitrite in sewage is usually so low as to be negligible.

ANALYSIS OF SEWAGE SLUDGE AND MUD DEPOSITS.

COLLECTION OF SAMPLE.

Collect a representative sample of the material. In general more than one sample should be taken from a spot and a large number of samples should be collected rather than a few large samples. If the surface layer is darker and a lower layer consists of pure clay, sample only the surface layer. Samples may be analyzed either separately or as composites of careful mixtures. After the sample has settled a few minutes roughly drain or siphon the excess water. Allow sewage sludge to stand for one hour before draining it free from excess water unless it is essential to determine the moisture content of the sample originally collected. If sludge cannot be analyzed within twenty-four hours it is better not to use air-tight bottles and to add small quantities of chloroform and keep in the ice box to retard decomposition. At the time of collection carefully examine mud from the bottom of surface water for evidence of sewage pollution and macroscopic and microscopic animal and plant organisms. Record the predominant species. Note the physical appearance of the material, particularly its colour, odor, and consistency. Express all analytical results in percentage on a dry basis.

REACTION.

Determine the reaction by diluting a definite quantity of the wet sludge and titrating by the methods given under alkalinity and acidity (pp. 35-39 and 39-41).

SPECIFIC GRAVITY.

Weigh to the nearest tenth of a gram a wide-mouthed flask of 100 to 300 c.c. capacity, according to the quantity of material available. Then completely fill the flask with distilled water to the brim and weigh it again. Empty the flask and fill it completely with fresh sewage sludge or mud. If the material is of such consistency that it flows readily fill the flask to the brim and weigh. The specific gravity is equal to the weight of the sludge or mud divided by the weight of an equal volume of distilled water.

If the material does not flow readily fill the weighed flask as completely as possible without exerting pressure during the procedure. Weigh and then fill the flask to the brim with distilled water. Let it stand for a few minutes, until trapped air has escaped, then add more water if necessary and weigh. Subtract the weight of the added water from the weight of the water that completely fills the flask; the specific gravity is equal to the weight of the material divided by this difference. Record the specific gravity only to the second decimal place.

MOISTURE.

Heat approximately 25 grams of sludge or mud in a weighed nickel dish on the water bath until it is fairly dry. Dry the residue in an oven at 100° C., cool and weigh. Repeat to approximate constant weight. The loss in weight is moisture.

VOLATILE AND FIXED MATTER.

Ignite, at dull red heat in a hood, the residue from the determination of moisture until all the carbon has disappeared. Cool the residue in a desiccator and weigh it. The residue is the fixed matter. The volatile matter is the difference in weight between the original dried sludge and the ignited sludge.

TOTAL ORGANIC NITROGEN.

Preparation of sample.—For the determination of organic nitrogen and fats dry approximately 50 to 75 grams of the sludge or mud in a porcelain dish first on the water bath and finally in the hot water oven until all the moisture has disappeared. Grind the dry material to a fine powder and keep it in a glass-stoppered bottle.

Reagents:
(a) *Sulphuric acid,* concentrated nitrogen free.
(b) *Copper sulphate solution.* Ten per cent.
(c) *Potassium permanganate.* Crystals.

Weigh accurately 0.5 gram of dried sludge or 5.0 grams of dried mud and put it into a 500 c.c. Kjeldahl flask. Digest it with 20 c.c. of sulphuric acid, or more if necessary, and 1 c.c. of copper sulphate solution to assist the oxidation. Boil for several hours until the liquid becomes colorless or slightly yellow. Oxidize the residue with 0.5 gram of potassium permanganate and neutralize with NAOH solution free from NH_3 and distil as in the organic nitrogen.

ETHER-SOLUBLE MATTER.

Fats are usually determined only on sewage sludge, but some mud deposits contain small quantities due to the presence of trade wastes.

Procedure.—Weigh 0.5 to 25 grams of dry material according to the quality of the sludge or mud. Add water to the weighed portion in a porcelain dish and acidify the mixture with N/50 sulphuric acid in the presence of litmus tincture or azolitmin solution as indicator. Avoid adding too much acid as an excess gives too high results on account of fatty acid residues. Evaporate the acidified mixture to dryness on the water bath, and heat it in the hot air oven at 100° C. two to three hours. Extract the dry residue with boiling ether, rubbing the sides and bottom of the dish to insure complete solution of the fat. Three extractions with ether are usually sufficient. Filter the ether solution through a 5 cm. filter paper into a small flask. Evaporate the ether slowly, dry the fatty extract for half an hour at 100° C., cool in a desiccator, and weigh. If it is desirable, particularly with certain industrial wastes, to determine the quantity of saponified fat determine the fats with and without the addition of acid. The difference between the quantities found by the two determinations is the content of saponified fat.

FERROUS SULPHIDE.

The liberation of hydrogen sulphide on adding dilute hydrochloric acid to a sludge indicates the presence of ferrous sulphide. As ferrous sulphide quickly oxidizes on exposure to air a quantitative determination of this constituent must be made immediately after collection of the sample.

Procedure.—Heat a definite portion of the sludge with hydrochloric acid in a flask. Pass the liberated gas through bromine water or hydrogen peroxide. Determine gravimetrically the sulphate in the oxidizing solution, and calculate the equivalent of ferrous sulphide by multiplying the weight of barium sulphate by 0.376.

VALUATION OF BLEACHING POWDER.

Reagents:

(*a*) *N/10 sodium thiosulphate solution.*

24.8 gms. of $Na_2S_2O_3 5H_2O$ are dissolved in a litre of distilled water at 15° C.

(*b*) *N/10 iodine solution.*

1.27 grams pure resublimed powdered iodine are weighed into a 100 c.c. flask, 20 c.c. of a 10 per cent. solution of potassium iodide (free from iodate) is then added and the mixture shaken gently until the iodine is dissolved. It is then diluted to a 100 c.c. with water at 15° C. Keep in the dark in a well stoppered bottle.

(*c*) *Starch solution.*

One to two grams of powdered white potato starch are mixed with 5 to 6 c.c. of cold water in a 250 c.c. beaker. Pour on the mixture boiling water until the appearance of the mixture changes suddenly to that of a semi-translucent gelatinous substance. Then add cold water until the beaker is nearly full. Settle and decant the clear supernatant liquid. Add drop of chloroform as preservative.

(*d*) *Potassium iodide solution.*

Five grams of potassium iodide in 100 c.c. of water.

(*e*) *Acetic acid.*

Five normal acetic acid.

Standardization of the sodium thiosulphate solution. Twenty-five cc. of the N/10 iodine solution are transferred by means of a pipette to a beaker, diluted with an equal volume of water. The N/10 thiosulphate solution is then run in slowly from a burette until the brown colour of the iodine solution pales perceptibly and the liquid assumes a straw colour. One or two drops of starch solution are then added and the thiosulphate solution delivered drop by drop until the blue colour is just discharged. If the solutions are strictly decinormal, 25 cc. of the thiosulphate solution should be used and 1 cc. of the thiosulphate solution will be oxidized by 0.0127 grams of iodine or 0.00355 gms. chlorine. The strength should be recorded on the label.

Analysis.

About 10 grams of the bleaching powder to be examined are weighed into a porcelain mortar, and rubbed down with a small quantity of water until the mixture has the consistency of thin cream; settle for a moment or two and decant the milky liquid into a litre flask. The residue is then ground down with a little more water and the process is repeated until the last traces have been transferred to the flask. The mixture is made up to a litre with water and thoroughly shaken. Twenty-five c.c. of the milky fluid are transferred by means of a pipette to a small beaker, the contents of the flask having been well shaken just prior to the withdrawal of the sample—10 c.c. each of the K1 solution and acetic acid are added. The titration of the thiosulphate is carried out as in the standardization of the thiosulphate against the iodine solution. As the strength of the thiosulphate is known the percentage of available chlorine in the original sample is easily calculated.

NOTE.—The standardization of the thiosulphate and the estimation of the C1 should always be done in duplicate.

Notes:—

VALUATION OF SULPHATE OF ALUMINIUM.

Reagents required:

(*a*) *Concentrated hydrochloric acid* sp. gr. 1.20.
(*b*) *Ammonium hydroxide* sp. gr. 0.90.
(*c*) *25 per cent. sulphuric.*
(*d*) *Methyl orange solution.*
(*e*) *Phenolphthalein solution.*
(*f*) *Bromine water.*
(*g*) *N/20 stannous chloride.* Should be frequently standardized against iron—1 c.c. N/20 stannous chloride=0.0028 grams of iron estimated in the ferrous state.
(*h*) *Normal sodium hydroxide solution*—free from carbonate.

To be determined:

Aluminium oxide.
Ferrous oxide.
Ferric oxide.
Basicity ratio.
Free sulphuric acid.

Insoluble Matter.

Dissolve 10 grams of the crushed sample (⅛ to ¼-inch diameter) in 100 c.c. water and digest at boiling temperature for one hour. Filter through a tared Gooch crucible. Wash the insoluble matter with freshly-boiled hot water. Dry to constant weight at 100° C. Cool and weigh, report as per cent. insoluble matter.

Oxides of Aluminium and Iron.

Dilute the filtrate from above to 500 c.c with water free from carbon dioxide. Measure 50 c.c. of the solution into a 250 c.c beaker. Add about 150 c.c. of water and 5 c.c. of hydrochloric acid and a few drops of nitric acid and boil. Add a few drops of ammonium chloride solution then ammonium hydroxide in slight excess. Digest for a few minutes at 100° C. Wash by decantation through a filter. Dry, ignite in a blast, cool and weigh. If much iron is present ignite the paper separately.

Subtract the total iron expressed as oxide and report the difference as aluminium oxide in percentage.

Total Iron.

Dissolve 10 grams of the sample in 50 c.c. of freshly-boiled distilled water, add 5 c.c. concentrated hydrochloric acid and 1 c.c. of bromine water. Evaporate to dryness. Dissolve the residue in water and wash into a flask making the volume up to 50 c.c. Add 50 c.c. concentrated hydrochloric acid, boil and titrate as hot as possible with N/20 stannous chloride.

FERRIC IRON.

Dissolve 20 grams in 50 c.c. of boiling distilled water to which has been added 50 c.c. of hydrochloric acid. Keep the mixture boiling till the sample is dissolved. Keep flask full of carbon dioxide by adding occasionally small amount of sodium carbonate. When sample is completely dissolved titrate immediately with N/20 stannous chloride.

FERROUS IRON.

Is calculated as the difference between the total iron and the ferric iron. Per cent. difference x 0.9 is the per cent. of ferrous oxide.

NOTE.—A rough method of estimating the total iron is to dissolve a sample and estimate the iron colorimetrically, as given for the estimation of iron in water.

BASICITY RATIO.

Fifty c.c. of the filtrate from the determination of insoluble matter is pipetted to a 200 c.c. casserole diluted to 100 c.c. and titrated at boiling temperature against N/1 sodium hydroxide solution, using phenolphthalein indicator. The percentage of acidity in enquivalent of sulphuric acid=number of cubic centimeters of sodium hydroxide x 4.9.

The percentage of sulphuric acid equivalent to the determined aluminium and iron oxide is calculated by the following formula:

$$2.88 \times Al_2O_3 + 1.83 \times Fe_2O_3 + 1.36 \times FeO.$$

If the percentage of acid equivalent is less than found by titration the difference is reported as percentage free acid, if greater the difference divided by 2.88 is the percentage equivalent to the excess aluminium oxide present. Divide this excess by the percentage of total aluminium oxide and report quotient as basicity ratio.

Notes:—

REPORT OF

The Provincial Board of Health Experimental Station

BULLETIN No. 6

INTRODUCTION

By F. A. DALLYN

A.—REPORT RELATING TO THE MANUFACTURE OF VITRIFIED CLAY SEWER PIPE IN ONTARIO

By A. R. DUFF

Assistant Chemist, Experimental Station

B.—SUGGESTED STANDARDS FOR SEWER CONSTRUCTION, INCLUDING PROPOSAL FOR BID OR ESTIMATE, BID OR ESTIMATE, BOND, CONTRACT AND SPECIFICATIONS

By F. A. DALLYN, C.E. (Tor.)

Provincial Sanitary Engineer

The Provincial Board of Health Experimental Station

BULLETIN No. 6

INTRODUCTION.

The Province of Ontario has an area of 126,000,000 acres. The population in 1915 was estimated as 2,767,350, of which approximately forty-two (42) per cent. is found in some 276 cities, towns and villages. The Statutes of Ontario relegate the supervisory control of all waterworks and sewer construction to the Provincial Board of Health, which authority is set out in The Public Health Act. The Provincial Board with the consent of the Lieutenant-Governor-in-Council may make such Regulations as may be deemed necessary for "the location, construction, repair, renewal, alteration and inspection of sewers, drain pipes, man-holes, gulley traps, flush tanks and other works in or upon public, municipal or private property forming part of or connected with any municipal sewerage system." (Sec. 8, s.s. ddd.) The Board in 1916 undertook an inquiry into the manufacture of vitrified clay pipe in Ontario. The findings are shown elsewhere in this volume. Certain regulations are suggested and it is hoped that they will be interpreted in no sense as a restraint on trade or development of engineering enterprise, but rather as an attempt to fix certain minimum requirements and provide for a limited standardization made necessary by the nature, magnitude and permanency of the work.

The position of the Board can be better appreciated when it is realized that from four to five million dollars' worth of construction is passed upon by the Board annually. The excellence of the Act as amended in 1912 is largely responsible for this splendid showing. Sec. 95 provides (1) "No by-law shall be passed for raising money for any of the purposes mentioned in sections 89 and 94 until the proposed water supply or sewerage system, as the case may be, has been approved by the Provincial Board of Health, and such approval has been certified under the hand of the Chairman and Secretary of the Board."

The Secretary is the executive officer of the Board and owing largely to the expeditious manner in which applicants come up for consideration, practically no complaint is heard and a general compliance is experienced, as is shown by the magnitude of the construction. It is of interest to other provinces that certain Ontario municipalities, at first resistant to the control of the Board, soon discovered that the cost of subsequently validating improper debenture issues or the cost of issuing proper debentures at a later date to re-establish the municipal bank account was considerably increased by reason of irregularities during construction, the validation involving as it does searches, certificates of the Railway and Municipal Board or Private Bills and in all instances the consent of the Provincial Board of Health as a fundamental necessity.

The work of the Board necessitated the creation of an Engineering Department and the operation of an Experimental Station. It was felt that the best service such a department could afford the Province was to act in a consulting capacity to the various municipalities within the limitation of the Statutes and by regulation direct their expansion along well considered and right lines.

The regulations governing the submission of plans were approved in October, 1914 (see page 195) and require that municipalities shall supply certain necessary information with each application, and since the work is largely an engineering matter, the information required is of a nature that it is necessary even for the smaller municipalities to avail themselves of the services of a qualified engineer. The Municipal Act recognizes this need and it is provided that engineering services may be charged to the undertaking and the money raised in the same manner as for the proposed work. It may be stated that in the experience of the Board the employment of a competent engineer works decidedly to the advantage of the municipality, and most decidedly affects cost, maintenance and the character and permanency of structure in the town plan.

Sewer trench, showing careless back filling over freshly-laid sewer.

The work of the Department has shown that there has been for some years past a recognized need in the Province for a specification covering the manufacture and laying of sewer pipe. The sewer pipe manufactured in Ontario is essentially different from the pipe imported into Ontario, both as to quality and appearance.

TABLE No. 1.

Name of Municipality.	Population 1914	Sewers and sewage disposal. Total expenditure up to 1914.	Sewers and sewage disposal. Dollars per head.	Water Works and Water Purification. Total expenditure up to 1914.	Water Works and Water Purification. Dollars per head.	Sidewalks. Total expenditure up to 1914.	Sidewalks. Dollars per head.	Roads, etc. Total expenditure up to 1914.	Roads, etc. Dollars per head.	Total of these items. Total expenditure up to 1914.	Total of these items. Dollars per head.
		$ c.		$ c.		$ c.		$ c.		$ c.	
*Berlin	18,338	413,222 70	22.5	....	....	130,000 00	7.1	....	....	....	....
*Bowmanville	3,519	54,151 86	15.4	101,920 35	29.0	35,000 00	9.9	2,500 00	.7	193,572 21	55.0
*Brampton	3,500	79,204 63	22.6	155,624 11	44.2	88,738 13	25.3	68,649 43	19.6	392,216 30	111.7
*Bridgeburg	1,713	89,072 62	52.0†	50,800 00	30.2	....	....	....	....	139,872 62	82.2
Cochrane	2,500	102,074 00	....	Sewers and Waterworks	*40.8	39,875 78	....	Sidewalks and Roads	15.9	142,949 78	56.7
Collingwood	6,646	87,944 00	13.2	74,373 00	11.2	68,304 00	10.3	30,000 00	4.5	260,621 00	39.2
Galt	11,932	420,562 52	35.3	276,355 17	23.1	148,012 73	12.4	15,711 61	1.3	860,641 83	72.1
Goderich	4,906	....	11.1	....	30.2	....	....	....	....	....	41.3
*Guelph	16,319	276,072 00	16.9	370,867 20	22.7	186,461 00	11.4	270,581 00	16.8	1,103,981 20	67.8
Haileybury	3,716	81,773 03	22.0	134,758 82	36.3	23,506 00	6.3	27,826 06	7.5	267,863 91	72.1
New Liskeard	2,200	54,613 31	24.8	90,763 70	41.2	8,328 67	3.7	5,000 00	2.3	158,705 68	72.1
North Bay	8,782	125,213 47	14.2	201,032 45	22.9	97,267 68	11.1	94,796 84	10.8	518,310 44	56.7
Peterboro'	20,150	208,909 15	10.3	512,000 00	25.4	219,743 03	10.9	24,776 92	1.2	965,429 10	47.9
Picton	3,615	....	....	35,000 00	*9.7	60,000 00	....	Sidewalks and Roads	16.5	*95,000 00	26.2
Port Arthur	18,025	906,165 00	50.3†	1,307,576 00	72.6	207,759 03	15.4	1,081,254 97	56.2	3,502,755 00	194.4
*Preston	4,923	75,000 00	15.2	128,000 00	26.0	42,387 82	8.6	....	none	245,387 82	49.8
*Rainy River	1,572	29,969 65	19.0	33,487 45	21.3	....	none	7,511 97	4.7	70,969 07	45.0
*Simcoe	4,117	61,633 00	14.8	90,012 00	21.8	47,504 17	11.4	3,000 00	.7	202,149 00	48.8
*Waterloo	4,737	113,555 66	24.0	101,000 00	21.3	83,872 50	17.7	112,119 51	23.7	409,547 67	86.7
*Weston	2,200	150,558 00	68.4†	83,000 00	37.7	21,000 00	9.5	....	....	254,558 00	115.6
*Woodstock	10,150	116,018 55	11.4	237,217 92	23.4	160,000 00	15.7	48,187 85	4.7	561,424 32	55.3
Average	....	average	16.2	average	30.0	....	....	....	....	average	72.1
Chicago	....	....	15.1	....	....	....	....	....	....	....	....
Detroit	571,372	in 1913	....	....	22.1	....	....	....	....	....	....

* Municipalities marked * have sewage disposal works. † Omitted from average.

TABLE 2.

Summary number of feet of Vitrified Clay Sewer Pipe Laid in the years 1911, 1912, 1913, 1914, 1915 by Ontario Municipalities.

Year.	6 in.	8 in.	9 in.	10 in.	12 in.	15 in.	18 in.	20 in.	22 in.	24 in.	30 in.	36 in.	42 in.	43 in.	48 in.	60 in.	72 in.	Total No. of feet.
1911..	18,924	19,855	60,884	26,551	157,422	38,453	28,084	......	......	14,123	108	......	1,390	552	1,520	310	1,088	369,274
1912..	24,841	46,543	46,076	49,840	138,980	36,243	27,458	872	......	23,207	1,292	1,738	235	1,803	1,860	1,390	2,094	404,472
1913..	28,616	21,882	83,232	21,950	160,628	40,710	28,448	1,738	......	18,145	6,227	2,390	195	......	......	......	......	414,161
1914..	19,808	44,356	122,861	39,276	227,203	71,954	37,978	5,269	1,770	34,174	97	......	3,740	......	......	......	......	608,486
1915..	23,661	16,533	61,117	10,257	102,774	29,224	20,316	1,002	......	10,548	1,152	......	......	......	......	......	......	276,584
Total.	115,850	149,169	374,170	147,874	787,007	216,584	142,284	8,881	1,770	100,207	8,876	4,128	5,560	2,355	3,380	1,700	3,182	2,072,977

Returns of municipalities to the Provincial Board of Health, 1916.

The investigation undertaken by the Board and set out in the report was primarily an effort to establish the worth of the Ontario product and to ascertain the possibility and the advisability of standardizing the sizes of pipe.

Tests were made and incorporated with report. The results indicate that Ontario pipe when well vitrified is extremely strong and that to all intents and purposes a standard size can be agreed upon which will permit of all municipalities using similar pipe and not as is the present case—having special requirements for each of the several larger users. A standardized product will then permit of the burning operation and whole process of manufacture being carried on more successfully and will overcome the necessity of mixing large and small sizes of pipe in the kiln.

The Dominion Sewer Pipe Co., Ltd., Swansea, Ont.

The needs of the Province are at this time sufficiently known and the proportion of the various sizes sufficiently established to permit of fairly large stocks being carried by the manufacturers.

There is no good reason why municipalities could not estimate and place orders for the major portion of their yearly requirements twelve months ahead of delivery and, where sewer construction is let by contract, provide that all pipe used is to be taken from the corporation's standing order at a price made known at that time. Such an arrangement works to the advantage not only of the manufacturer but of the municipal corporation and the labour connected with the industry as well.

Incidentally other information relating to the manufacture and distribution of pipe has been obtained by the Board and as far as possible has been included in the text for the information of City Engineers, Inspectors and students interested.

In the effort to determine the extent to which sewer pipe is used throughout the Province the following summaries will be of use in correlating the effect of increase in population and the need and extent of building and sewer construction. (*a*) The sewerage systems of the Province of Ontario cost on an average of $16.2 per capita. (*b*) The average dwelling in Ontario cities has 4.21 persons occupant; (*c*) The average total cost per dwelling = $16.2 x $4.21 = $68.2. (This does not include the cost of house connections.)

Table No. 1 fairly summarizes the pre-war development of a few Ontario municipalities:

It is with difficulty that a clear idea can be had of the probable demand after the war for municipal improvements, especially sewerage. Sufficient to say that a rapid increase in population by immigration is anticipated. Table No. 2 is a summary of the vitrified clay tile pipe laid by some twelve cities and nineteen towns representing approximately ninety per cent. of the total amount of sewer pipe laid in Ontario for the noted years.

The Department of Customs reports, as to the value of drain and sewer pipe imported into Ontario during the fiscal years ending 31st March, 1911, 1912, 1913, 1914, 1915, 1916, are incorporated in Table No. 3.

TABLE 3.

Importation of Sewer Pipe into Ontario.

Year ending March 31st.	Great Britain.	U. S. A.
	$	$
1911	3,150	31,742
1912	3,584	53,867
1913	15,389	72,679
1914	4,747	81,194
1915	10,152	86,079
1916	5,114	13,843

The figures presented in the following table will support the conclusion that even under existing conditions an Ontario industry of considerable magnitude has developed in the manufacture of vitrified clay sewer pipe and in point of output the Ontario plants are readily capable of supplying the entire demand of the Ontario Municipalities.

TABLE 4.

Value of Sewer Pipe manufactured in Ontario for the noted years.

From the Census and Statistics Office the following information was obtained:

Census Return. 1900.	Census Return, 1910.	Mines Report Return 1915.
$ 369,631	$ 623,458	$ 795,646

An attempt to explain the importation of pipe from the United States of America would involve a discussion of freight rates to Western points in the Province which at present are equivalent to 50 per cent. of the net value of the pipe at the factory and also a discussion of the engineering prejudice against the inferior pipe included in shipments frequently (if gossip were truth) literally forced on some of the smaller municipalities by Ontario manufacturers.

The inquiry, the report and the recommendations first as to manufacture, second, as to standard sizes, are attempts to be of real assistance to the municipalities without any interference with the powers properly vested in Municipal Councils, powers so typical of our Ontario development of municipal control.

The Suggested Standards for Sewer Construction include Proposal for Bid or Estimate, Bid or Estimate, Bond, Contract and Specifications, and certain Standard Details of Construction.

A most novel feature of the proposed standard form of Proposal for Bids or Estimates, is the introduction of an engineer's estimate of quantities, the responsibility of which is assumed by the municipality, the municipality being amply protected by the municipal rates for extra work, included in the contract agreement. These have been suggested for the reason that no municipal record is complete which does not permit of future analysis. Unfortunately with very few exceptions municipal records are very indifferently kept from this point of view and it is for the same reason that in applications for the Board's approval it is required that the following table be filled in:

TABLE No. 5.—SUMMARY OF COST.

Classification of Work	Units	Quantities	Rate	Amount
Sewer Material only..........................	per foot	....	....	....
Sewer Material only..........................	per foot	....	....	....
Sewer Material only..........................	per foot	....	....	....
Sewer Material only..........................	per foot	....	....	....
Laying Sewer	per foot	....	....	....
Laying Sewer	per foot	....	....	....
Laying Sewer	per foot	....	....	....
Laying Sewer	per foot	....	....	....
Excavation and Backfilling in	per cu. yd.	....	....	....
Excavation and Backfilling in	per cu. yd.	....	....	....
Excavation and Backfilling in	per cu. yd.	....	....	....
Tunnelling on	per foot	....	....	....
Repair to Pavements........................	Total	....	....	....
Resurfacing Street..........................	Total	....	....	....
Building Manholes, complete..................	each	....	....	....
Building Lampholes, complete................	each	....	....	....
Building Flush Tanks, complete	each	....	....	....
Gullies and Catch Basins, complete...........	each	....	....	....
Branches	Total	....	....	....
Engineering and Inspection	Total	....	....	....
Extras	Total	....	....	....
Anticipated Bond Issue Depreciation.........	below par	....	....	....

Records are essential, if any proper control is to be had over extravagant construction and if logical town planning is to be realized. The items for sewer construction most capable of variation are the type of material to be excavated and the handling of labour. It is only by taking advantage of careful analytical study of costs that municipal engineers can give advice as to whether they themselves or contractors on municipal work are taking the fullest advantage of their labour and equipment and as to whether the work has been constructed economically or not. So many councillors and local engineers continue to believe that all things are satisfactory for which satisfactorily signed vouchers can be produced without inquiry as to whether the work could have been done just as satisfactorily at thirty or forty per cent. less cost.

In recommending fuller information on the part of the Engineer in preparing plans and estimates it may be said that contractors in estimating must of necessity leave ample margins to provide for unexpected contingencies made possible by the vagueness of the Engineer's plans or lack of information, and also for profit. These contingencies do not usually arise although they are almost invariably provided for by the contractor; that is, contractors undertake to carry on work with a safe margin of profit. It has been incorrectly assumed by some municipalities that contractors bidding on work the character of which they are ignorant of will as a rule under-bid the job. Incidents of under-estimations are becoming less and less frequent. In the long run it must be appreciated that no contractor can continue work at a loss, and what is lost on one job is naturally provided for in another. So that a municipality doing considerable construction will pay the contractor's profit and any losses he may have sustained.

It is now recognized by all engineering bodies and admitted by contractors that the fuller the knowledge or information submitted at the time of asking for bids, the freer the bidding and the closer the proposals. Concealed knowledge undoubtedly works to the advantage of the favoured contractors, but, in general, increases the bidding all the way through. The favoured contractor, while bidding lower than others, will have a wider margin and almost invariably will bid higher than if the bid were open; that is, his bidding in all probability is not as low as if the bidding were truly competitive.

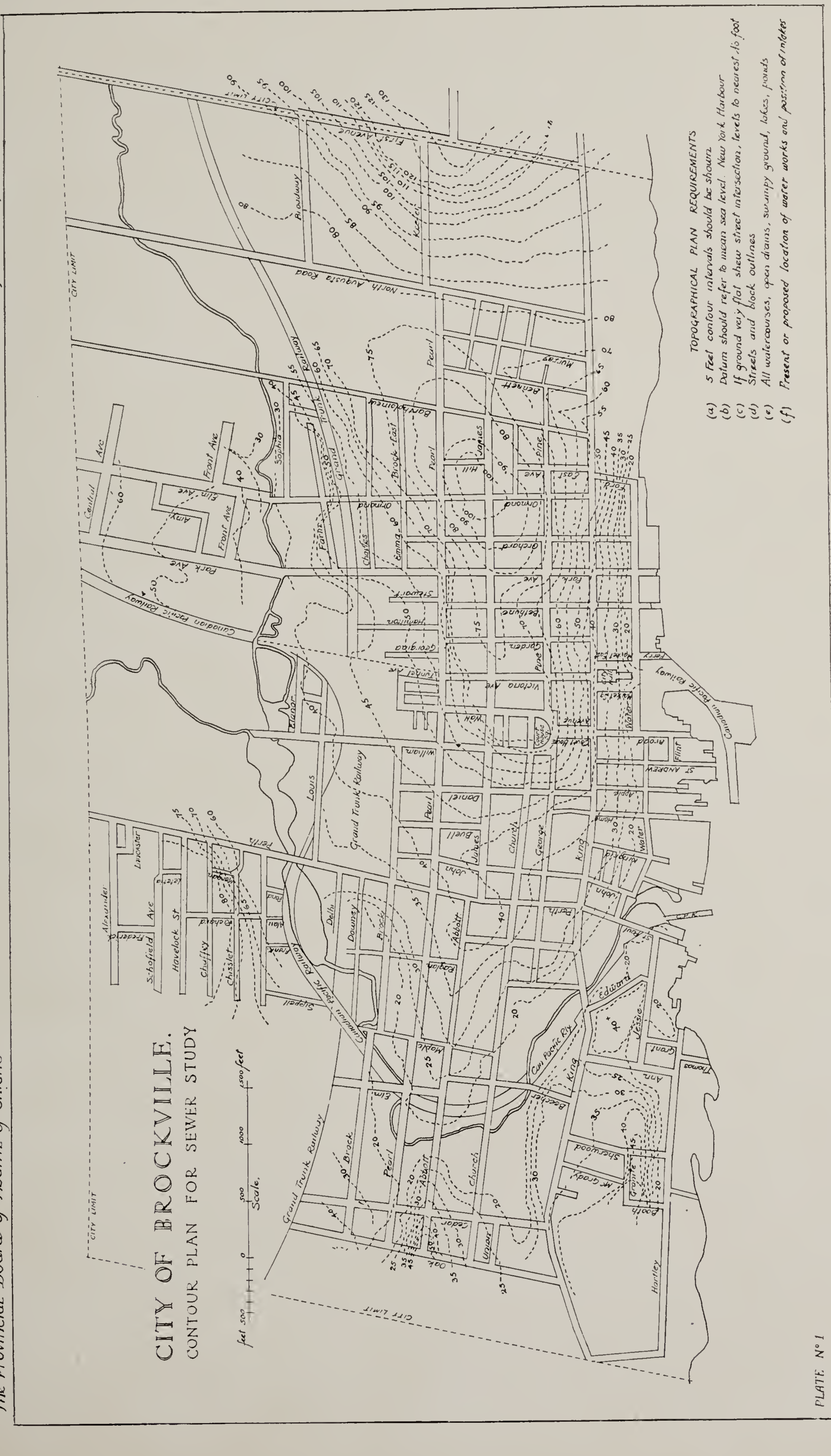
In some instances a contractor will be able to bid very much lower than another in view of the fact that he may have an idle plant or adjacent contracts which give him advantage over others not so favourably situated. In new work the competitive bidding should be fairly close and the total costs will provide for labour, cost of material, interest on plant investment, moving of equipment, restoration of streets, maintenance, interest on guarantee and withheld moneys, together with contractor's profit.

Where a municipality is doing its own work, several of these items do not enter into the cost and frequently the City Engineer has as much as 20 per cent. margin over and above that which a contractor should bid. For proper comparison of proposals the City Engineer should not include profit in his undertaking, but should include contingencies. The debenture issue should include provision for variation from par value at time of sale.

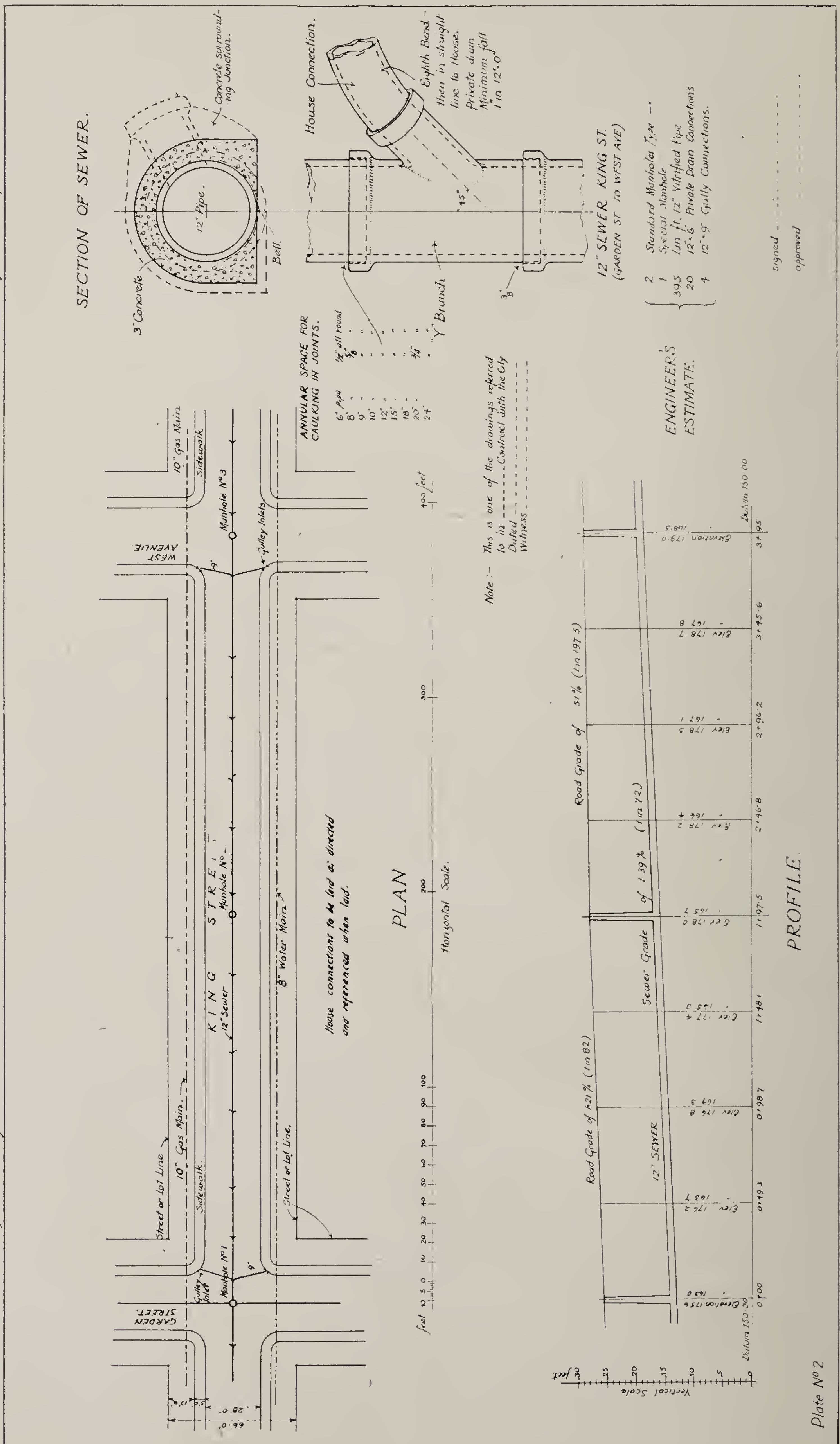
Schedules and forms for the keeping of cost data for municipal sewer construction are included with the proposed standards for sewer construction. When the work is done by contractor the resident engineer should be required to keep such forms. The actual cost to the contractor will not always be obtained but many items affecting the work and subsequent letting of contracts will be known and can be taken advantage of. The standard details of construction included in this report are mainly for the information of students and the younger of the municipal engineers.

F. A. Dallyn.

Standards for Municipal Records 1915.



The Provincial Board of Health of Ontario


The Provincial Board of Health of Ontario.
Standards for Municipal Records 1915.
SECTION OF SEWER.
3" Concrete
12" Pipe.
Bell.
Concrete surround-ing Junction.
House Connection.
Eighth Bend - then in straight line to House.
Private drain Minimum fall 1 in 12'-0"
45°
"Y" Branch
12" SEWER KING ST.
(GARDEN ST. TO WEST AVE)
ANNULAR SPACE FOR CAULKING IN JOINTS.
ENGINEER'S ESTIMATE.
2 Standard Manholes Type
1 Special Manhole
395 Lin ft. 12" Vitrified Pipe
20 12"x6" Private Drain Connections
4 12"x9" Gully Connections.
signed
approved
Note:- This is one of the drawings referred to in Contract with the City
Dated
Witness
WEST AVENUE.
GARDEN STREET.
K I N G S T R E E T
12" Sewer
Manhole No 1
Manhole No 3.
10" Gas Main
8" Water Main
Sidewalk
Street or Lot Line
Gulley Inlets
House connections to be laid as directed and referenced when laid.
PLAN
Horizontal Scale.
Road Grade of 51% (1 in 197.5)
Road Grade of 1.21% (1 in 82)
Sewer Grade of 1.39% (1 in 72)
12" SEWER
Vertical Scale
Datum 150.00
PROFILE.
Plate No 2

REGULATIONS GOVERNING THE PREPARATION AND SUBMISSION OF PLANS AND SPECIFICATIONS RELATING TO A SEWERAGE SYSTEM, SEWAGE DISPOSAL SYSTEM, COMMON SEWER OR EXTENSIONS TO THE FOREGOING.

Approved by the Lieutenant-Governor-in-Council on the 5th day of October, 1914.

Section A

An application for the approval of a sewerage system shall be accompanied by:

(1) A topographical map covering the entire municipality or sewerage district, together with contours indicating the nature of the adjoining watershed. This map shall clearly show the existing, proposed and ultimate main sewers intended for the area. The sizes of sewers must be plainly written along the lines of the sewerage system.

12″
————o————

(2) Profiles of all sewers proposed for immediate construction, which shall show by means of figures and other suitable symbols the sizes, lengths, gradients, surface elevations of the sewer invert, elevation of sewer inverts at manholes and the material and nature of the sewer construction. Gradients ensuring self-cleansing velocities will be expected when obtainable by the nature of the topography of the section to be sewered. It is further required that the elevation of the floor of the lowest cellar be mentioned on the profile drawing. Test hole information showing character of subsoil and such other information necessary to aid contractors in bidding will be required for new sewerage systems, new sub-divisions and for larger undertakings. Test hole information is not required for small jobs where the nature of the sub-stratum is known.

(3) Plans of all sewer appurtenances, such as manholes, lampholes, flush tanks, siphons, unusual features, pumps, etc., shall be required. It is suggested that details of manholes, flush tanks, catch basins, etc., be placed on the profile drawing or that they be standardized and bound together with the standard specifications.

(4) Specifications or allusions to a Standard Specification already filed with the Board, together with a copy of the Engineer's preliminary estimates of cost subdivided into the various main headings, shall be required.

(5) Further the Corporation shall produce evidence that by-laws either have been passed or will be passed forthwith, providing that all outhouses and privies shall be removed or destroyed on those premises abutting on streets which have sewerage facilities or upon those premises which by reason of their situation may connect to existing sewers, and that such premises are required to connect to the adjacent sewer.

Section B

An application for the approval of common sewers or sewer extensions shall be accompanied by:

(1) Plans and specifications or plans together with an allusion to a standard specification previously submitted as required for subsections 2, 3, and 4 of Section (*a*), relating to the particular extension. It is suggested that when several profiles are being submitted at one time these be blue-printed on a single, long sheet, instead of in sections. (Filing and examination is thereby much simplified.)

(2) A report in the case of new outlets showing their relation to the existing system and setting forth the reason why existing outlets are not used.

Section C

An application for the approval of a sewage disposal works shall be accompanied by:

SHORING OF TRENCHES.

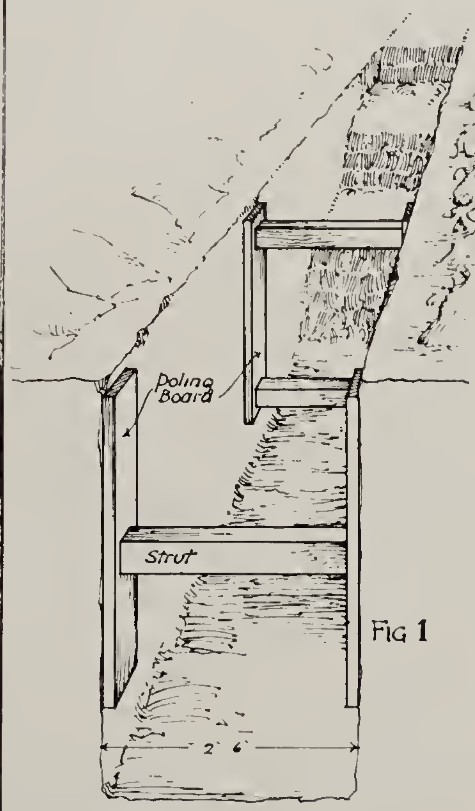


Fig 1

NARROW TRENCH IN FIRM GROUND
Shewing Single & Double Struts

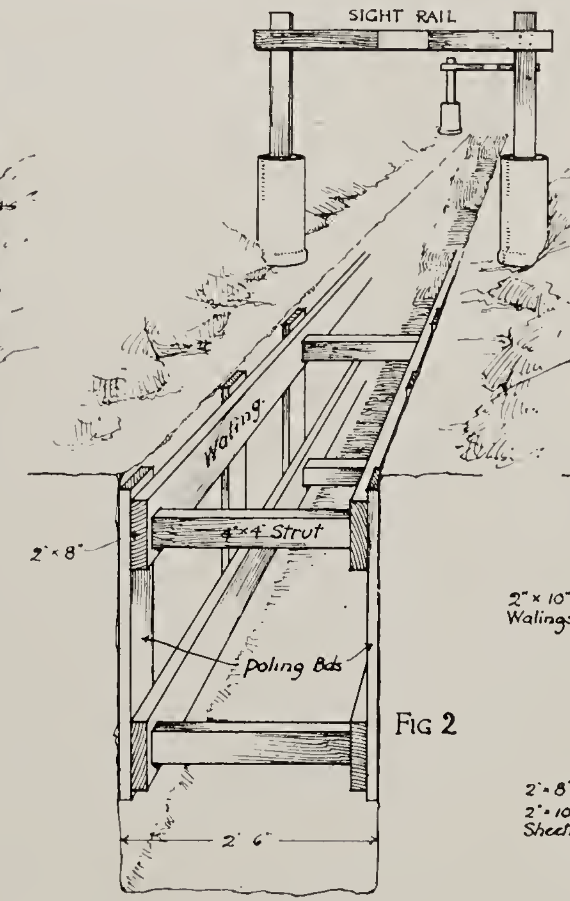


Fig 2

NARROW TRENCH IN MODERATELY FIRM GROUND
Shewing open Poling boards, Walings & Struts

Notes:- Poling boards are 1½"×8", 1½"×10" × 3'-0" long. Walings are 2"×8", 2"×10" + in the larger trenches 4"×8", 4"×10" etc. The first set of Walings are usually placed 1'-0" below the ground + the succeeding lower sets at 4'-0" centres.
Struts, also called Braces are 4"×4", 6"×6" or 8"×8" + 4" to 6" diam when round.
They are placed 6'-0" apart (horizontally) except at joints in walings, when the adjacent struts may be 4'-6" used in conjunction with intermediates of 6"×6".
The Struts may have to be further apart on account of the size & working of excavating machinery.
Two sets of sheeting could be used in shoring a trench 16'-0" deep (as Fig 4) and is preferable to one long set both on account of ease in withdrawing the smaller sheeting & general convenience.
In materials which are likely to run the planking should be driven slightly ahead of the excavation.

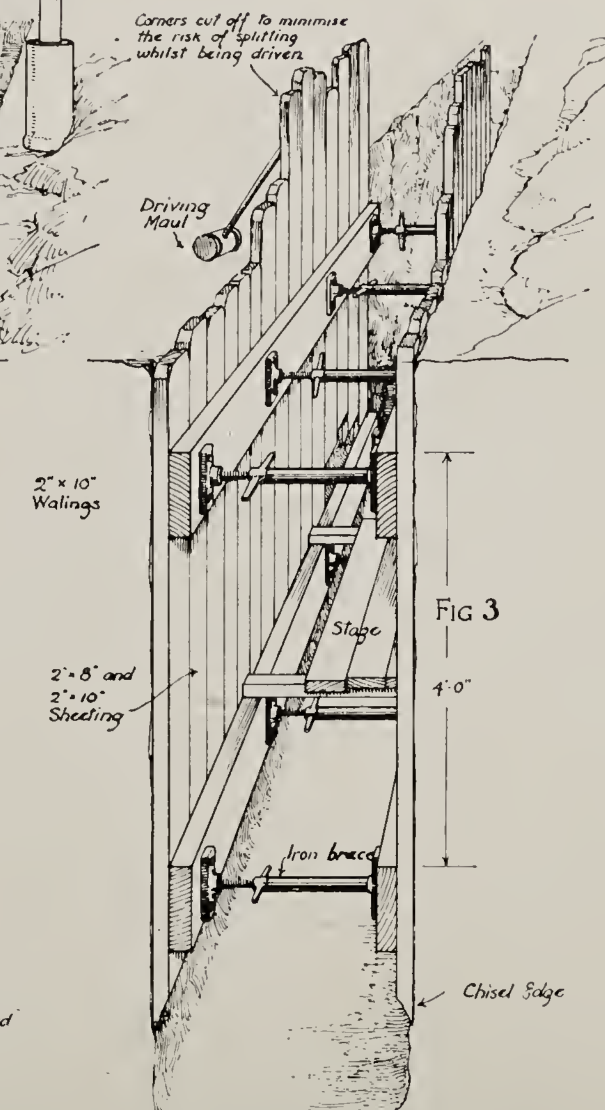


Fig 3

NARROW TRENCH IN LOOSE SAND
Shewing Close Vertical Sheeting, Walings & Iron Screw braces

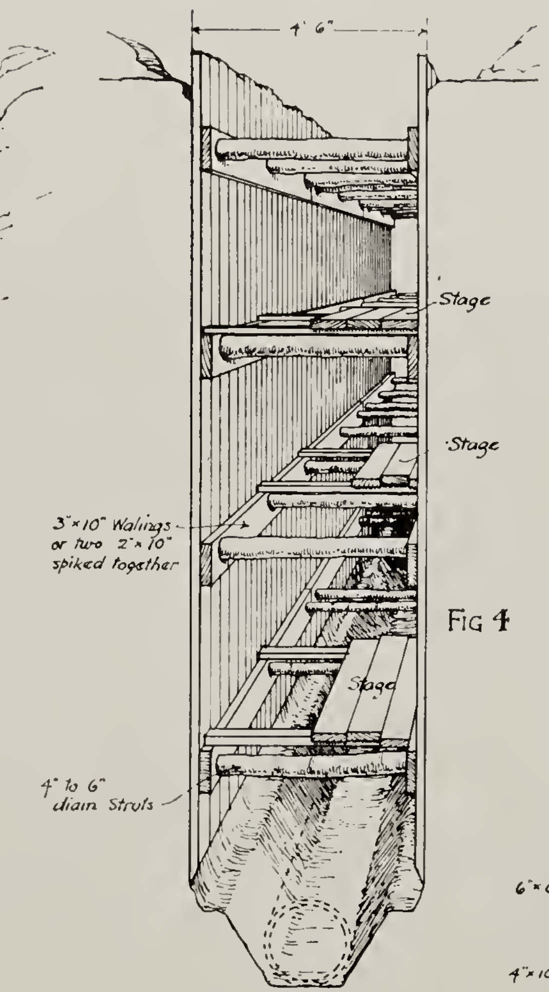


Fig 4

TYPICAL SHEETING & BRACING FOR TRENCHES UP TO 16 FT DEEP

Note:- Figs 4 + 5 are drawn to half the scale of Figs 1, 2 + 3 and in reality are trenches twice as large in comparison with the preceding three

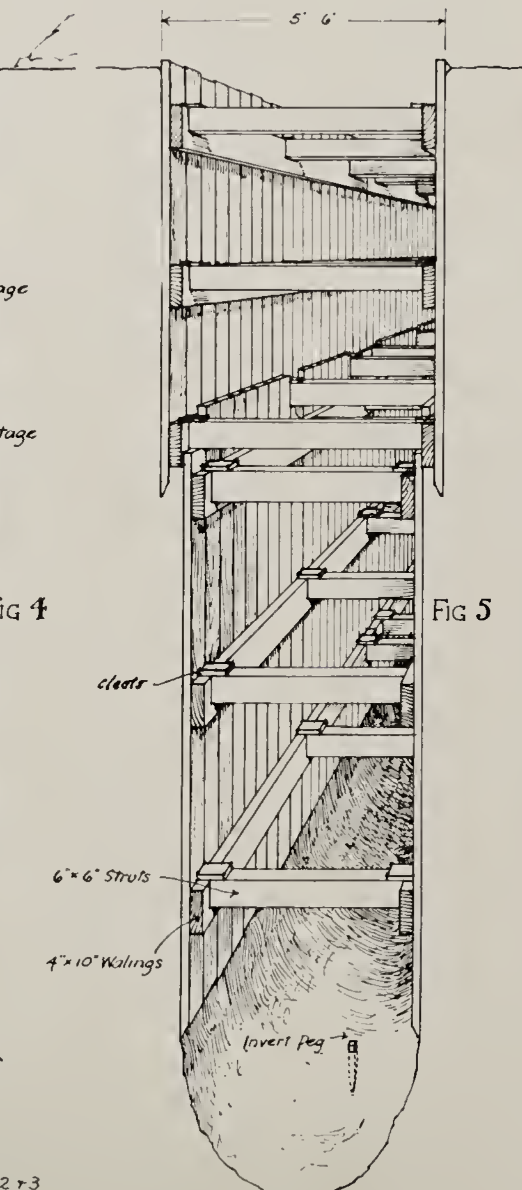
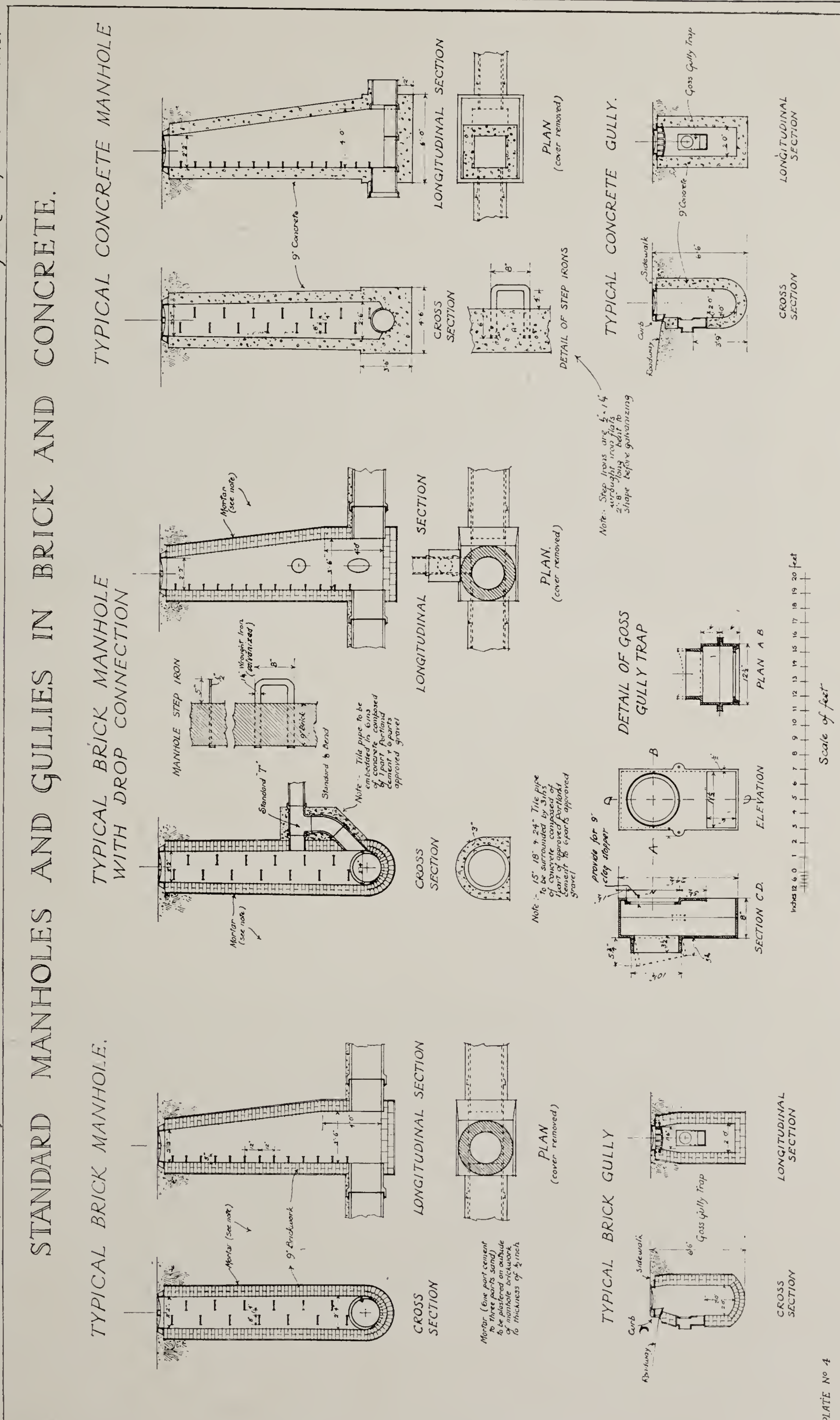


Fig 5

TRENCH IN LOOSE SOIL 16 FT DEEP & OVER IN TWO SETS OF SHEETING (Upper 8'-0" Lower 12'-0") in this case

PLATE No 3


The Provincial Board of Health of Ontario.
Standards for Municipal Records 1915.
STANDARD MANHOLES AND GULLIES IN BRICK AND CONCRETE.
TYPICAL BRICK MANHOLE.
CROSS SECTION
LONGITUDINAL SECTION
PLAN (cover removed)
Mortar (see note)
9" Brickwork
Mortar (one part cement to three parts sand) to be plastered on outside of manhole brickwork to thickness of ½ inch
TYPICAL BRICK MANHOLE WITH DROP CONNECTION
Standard "T"
Standard ⅛ Bend
Note:- Tile pipe to be embedded in 6 ins of concrete composed of 1 part Portland cement to 6 parts approved gravel
MANHOLE STEP IRON
Wrought Iron (galvanized)
9" Brick
Note:- 15" 18" & 24" Tile pipe to be surrounded by 3 ins of concrete composed of 1 part of approved Portland cement to 6 parts approved gravel
TYPICAL CONCRETE MANHOLE
9" Concrete
DETAIL OF STEP IRONS
Note:- Step Irons are ⅞ x 1¼ wrought iron flats 2'-8" long bent to shape before galvanizing
TYPICAL BRICK GULLY
Roadway
Curb
Sidewalk
Goss Gully Trap
DETAIL OF GOSS GULLY TRAP
provide for 9" clay stopper
SECTION C.D.
ELEVATION
PLAN A B
TYPICAL CONCRETE GULLY.
Scale of feet
PLATE No 4

(1) A small scale topographical map showing the main collectors, together with the situation and size of the disposal area.

(2) An Engineer's report upon the proposed works, describing the necessity thereof and the benefit to be derived therefrom.

(3) An actual estimation of the existing flow of sewage from various districts or at convenient outlets made by means of weirs or other suitable measuring devices must be included with the description of the works.

(4) Detail plans and specifications for the construction of the proposed works, together with the Engineer's preliminary estimate of cost.

(5) It is recommended that no disposal works other than the acquiring of land and the construction of sedimentation tanks be provided for at the time of construction of the main drainage scheme, but that suitable experiment and research be made as to the proper methods of disposal after actual conditions of flow have been established, the results from these experiments and researches being used in final design of the disposal works.

SECTION D

An application for the approval of combined systems or storm sewers shall be accompanied by:

(1) A set of topographical maps of the natural surface water drainage divisions of the municipality. These may be enlargements taken from the general topographical map, upon which shall be shown the proposed storm sewers. The sizes of the sewers must be plainly written along their lines of direction.

(2) Profiles, specifications and a plan showing typical sewer cross sections, manholes, etc., for that portion of the system covered by the construction by-law.

(3) An Engineer's report of the proposed system, which report shall be in detail and shall include the information relating to sub-strata and ground water level, areas paved, nature of ground surface, local by-laws affecting collection and separation of roof water, mean slopes affecting run-off, and the area of each natural division, together with a complete record of data relating to precipitation affecting the municipality.

(4) A plan showing the locations of connections between the sanitary and storm sewers, together with a report upon the mean flow and its relation to the excess flow which operates the separating weir.

SECTION E

Completion of work:

(1) Upon completion of the work a revised plan showing the alterations and deviations from the original plans, together with a final estimate of cost, shall be forwarded to the Board.

Stripping the surface loam off a clay field.

Stripping sewer-pipe clay near Hamilton, Ont.

THE MANUFACTURE OF VITRIFIED CLAY SEWER PIPE IN ONTARIO.

By A. R. Duff, Assistant Chemist Experimental Station.

*"The clays used in the manufacture of sewer pipe in Ontario are confined chiefly to the district east of Hamilton, principally in the vicinity of Waterdown station on the Grand Trunk Railway, the deposits probably covering an area of five or six square miles in extent.

Location of Sewer Pipe Clay

"The clay is obtained from two sources in this locality, either the weathered and softened top of the Queenston (formerly known as Medina) shale, which occurs mostly in knolls and ridges north of the railway, or from a transported clay, consisting chiefly of this material, which has been washed down to lower levels south of the railway line.

"The weathering action of the shale is twofold; softening and leaching. The softening increases the plasticity of the shale very considerably, the leaching decreases the lime content.

"Both processes are essential in producing a clay for sewer pipe, as smoothness of surface and the ability to take a salt glaze are obtained by using the weathered clay. These qualities could not be obtained in the finished product by using the hard unweathered shale.

"Weathering action must have taken many centuries to soften the shale and leach out sufficient lime to make these top layers suitable for sewer pipe manufacture. There is no known artificial method for either rapidly or economically bringing about the desired condition."

The weathered in situ is found overlying the hard shale in a sheet from one to four feet or more in thickness, being thicker in depressions or on level ground, and thinner on sloping ground or knolls. Even on level ground the surface of the hard shale underlying the clay is irregular, so that in some places the amount of clay to be obtained is greater than in others.

"The transported clay is found over a considerable stretch of ground, principally south of the railway line. Many of the fields here are already stripped of clay and returned to cultivation of crops. A section showing the series of beds general to the locality is exposed in the clay pit worked by the National Fire Proof Company. It consists of about four feet of stiff, plastic, reddish clay, underlaid by about two feet of brownish sand. The sand is underlain by about three or four feet of alternating clay and silt layers to the bottom of the pit, with gravel and stony clay below. The upper four feet only is used for sewer pipe, silo blocks or other salt glazed goods. It strongly resembles the softened shale on the higher levels north of the railway track, from which it most probably has been derived.

"The clay in both places runs somewhat uneven in character, the best quality being red or brown, with a slight waxy lustre when freshly dug. It breaks up into small cubes and is exceedingly smooth and highly plastic when wet. A less plastic clay, of lighter colour, which crumbles finely on pressure between the fingers, occurs in small quantities throughout the stiff clay.

"The sewer pipe clay is liable to contain certain impurities, such as small pebbles of limestone, or streaks and lenses of sand and silty clay having a high lime content. These impurities are harmful, as the limestone pebbles burning to quick-lime cause soft white spots on the pipe, and the sand or silt, if present in any appreciable quantity, decreases the working qualities of the clay in the raw state and prevents the formation of a salt glaze, at the final stage of manufacture.

*An extract from the report on Clays of Ontario by Joseph Keele, Dominion Government Ceramic Engineer.

"The gathering of clay in the field is one of the most important stages in the successful manufacture of sewer pipe in this district.

"The method of winning clay is as follows: The surface sod is removed by scrapers after a shallow plowing. This is followed by a deeper plowing, and the clay thus loosened is shovelled into carts.

Winning Clay

"The carts are hauled to a raised platform alongside the nearest railway siding and dumped into coal cars, three of which provide the average daily allowance for a factory. The clay deposited is plowed downward until all the weathered clay is exhausted, and then the field is abandoned. The foreman in charge of the operation watches the changes that occur in the character of the clay as the plowing proceeds downward. He is provided with a bottle of acid for the purpose of testing doubtful clay. If a few drops of acid poured on the doubtful clay produces effervescence it is generally rejected. It is often impossible to prevent some doubtful clay from going into the cars owing to the uneven thickness of the weathered portion, or to exclude patches of limey clay."

It is suggested that if exposed surfaces are allowed to weather for several days before winning a clear demarcation is shown between clay and high lime streaks which can readily be taken advantage of.

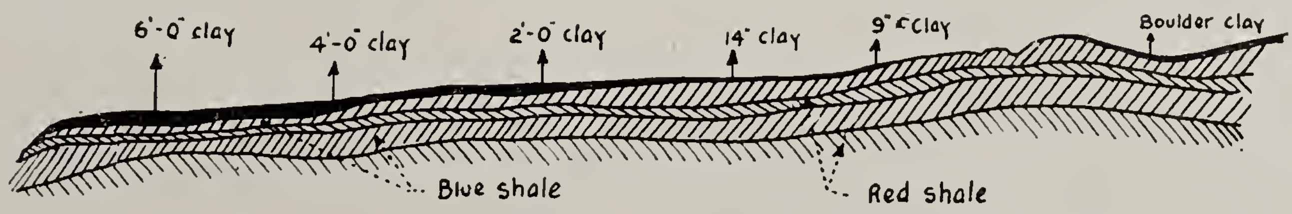
Analysis of Several Sewer Pipe Clay Fields Showing Position of High Lime Clay.

TABLE No. 6.

No.	Depth of Sample.	Lime Content.		
		Location (1)	Location (2)	Location (3)
1	Top 6 inches	None	1.05	Trace
2	6 " to 12 inches	Trace	1.05	....
3	2 feet	0.49	2.25	0.5
4	2 " 6 inches	0.71	....	....
5	3 " 6 "	2.00	13.0	1.1
6	4 " 0 "	2.9	12.5	0.9
7	5 " 6 " shale	7.2	....	3.5
8	25 " shale	7.2	....	....

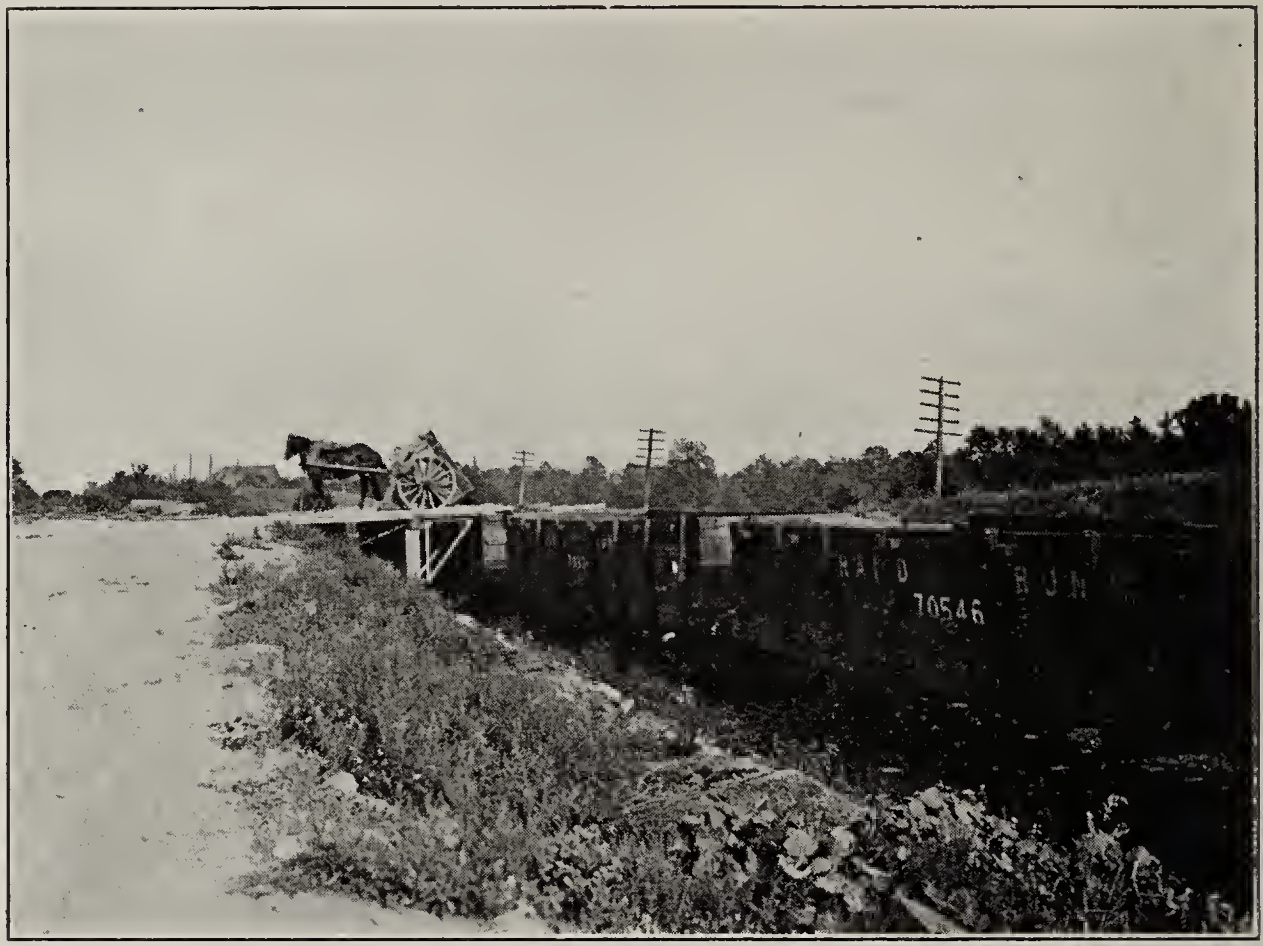
Field Work—Mr. Duff.

A typical cross section of fields which are being stripped of sewer pipe clay.



Only the dark portion and for the indicated depths is suitable for sewer pipe industry.

The sewer pipe clay is a mixture of the weathered blue and red shale and sand.



The clay is transported from field to factory by railway.

Clay fields, showing gathering of the lower high-lime clay used for hollow building blocks. National Fire Proofing Co., Ltd., pit.

Clay storage and receiving room. Toronto-Hamilton Sewer Pipe Co., Ltd.

Clay storage room, showing dry-pan, Hamilton factory.

TABLE No. 7.

*Analysis of Sewer Pipe Clay, Ontario.

Sample.	Silica per cent.	Alumina per cent.	Ferric-oxide per cent.	Lime per cent.	Magnesia per cent.	Sodium per cent.	Potasium per cent.	Sulphur Trioxide per cent.	Loss by heat %
Red-burning Medina shale	65.04	16.14	6.37	.80	2.17	.64	3.21	.12	5.98

Waterdown, Ontario.

The clay as it comes from the fields contains considerable moisture depending on weather conditions. To pass the clay through the screens it is necessary to have it quite dry (not more than 10 per cent. moisture) and for this purpose a large drying floor built of concrete and heated by steam pipes is provided. When the clay reaches the factory it is shovelled to a sloping platform and slides to the drying floor. Here it is distributed evenly from the floor, each successive car or shipment making a fresh layer or lamina over the others. The dried clay is dug in perpendicular sections from these laminæ of different shipments and so aids in the mixing of the clay. All operations from the field to the pipe presses help to insure a thorough mixing of the clay and a more uniform quality of product from the factory.

Belt conveys take the clay from the drying floor to the dry pans where the clay is ground very fine. It then falls through the perforations of the pans after which it is elevated and made to fall over piano wire screens set about ten to the inch. That which goes through the screen is elevated to a storage hopper and the coarser material chutes back to the dry pan to be reground.

The wetting or tempering of the clay is the next step in the process. This is done in a grinding and mixing pan—commonly called the wet pan or tempering pan—the bottom of which is not perforated. The tempering pan is fed from the storage hopper with dry ground clay. Water is added to each charge and the mixing continues until the clay has the correct plasticity. It is then spaded from the constantly revolving pan to a belt which conveys the carefully prepared material to a hopper situated over or near the pipe press. This prepared clay cannot be stored in large quantities because its water content is liable to change due to evaporation. The behaviour of the clay in the pipe press is largely dependent upon a variation not greater than 1½ per cent. in its water content. If too much water is added the clay will leave the press in a very smooth condition, but will not have sufficient strength to permit of handling on the drying floor. On the other hand if insufficient water is added the clay is not sufficiently plastic and does not go through the die readily and is apt to cause laminations in the pipe.

Tempering pan

The usual procedure in adding the water to the ground clay is as follows:

The wet pan which is 7 feet in diameter and about 18 inches deep revolves continuously. Dry clay (about 10 per cent. moisture) is added by drawing a slide in the clay chute. At the same time water is added from a 1½-inch pipe. When the operator sees enough clay has been added he closes the clay chute and shuts off the water. Very heavy steel crushing rolls rest on the bottom of the pan and are caused to rotate by the moving pan. Stationary guides scrape on the pan surface and throw the clay under the heavy rollers.

Tempering the clay

*Report of the Bureau of Mines, Part II Ontario, 1916. Clay and the Clay Industry of Ontario.

The action is to crush the clay and mix in the water. The workman catches a handful of the material and by squeezing it in his hand decides whether the mix is too soft or too stiff and he adds water or dry clay as required. If he is not judging correctly the man at the press signals that the mix is too stiff or too soft and the temper-pan man changes the consistency accordingly. The man at the wet pan becomes very expert at judging the moisture content by the feel of the clay.

For very large pipe the clay is required not so stiff as for smaller sizes. The reason of this is that when pressing 24-inch pipe a very large cross section of clay is pressed through the die and the clay must be soft enough to pass through with the available pressure behind it. It must, however, be stiff and strong enough to hold a weight of four or five hundred pounds during the interval between when the pipe has been pressed out to its full length and when the revolving cutter severs its connection from the clay in the press and transfers the weight of the pipe to the platform below.

The small 4-inch pipe can and must be stiffer. There is a much greater available pressure for the small sizes. The steam piston 40 inches in diameter has a pressure of 120 pounds per square inch behind it and in the clay cylinder with a piston 18 inches in diameter there is a pressure of approximately 590 pounds per square inch. The lower end of the clay cylinder and entry to the 4-inch die is conical and so the pressure on the clay passing through the 4-inch die may be 600 pounds per square inch or more.

On the 24-inch pipe a 21-inch dia. clay cylinder with a pressure on its piston surface of 473 pounds supplies the clay for a 24-inch die and so the pressure on the clay passing through a 24-inch die may be less than 350 pounds per square inch.

These figures are based on a gauge reading of 120 pounds, the 24-inch press has a 44-inch steam cylinder and a 21-inch clay cylinder. The 4-inch or smaller press has a steam cylinder 40 inch diameter and a clay cylinder 18 inches in diameter.

The 4-inch pipe are thin walled, are as long as the 24-inch pipe and are more apt to bend and warp in handling. The extra pressure available at the press for small pipe permits of a stiffer mix.

The factory executives may be fortunate in securing a man or men of careful judgment for operating their tempering pans, but with constantly changing workmen the safest method of controlling the proportion of water in the tempered clay would be to use some instrument or machine that would give an accurate measure of the behaviour of the water content. Such a machine would not need to be used for every mix but as a check on the man's judgment.

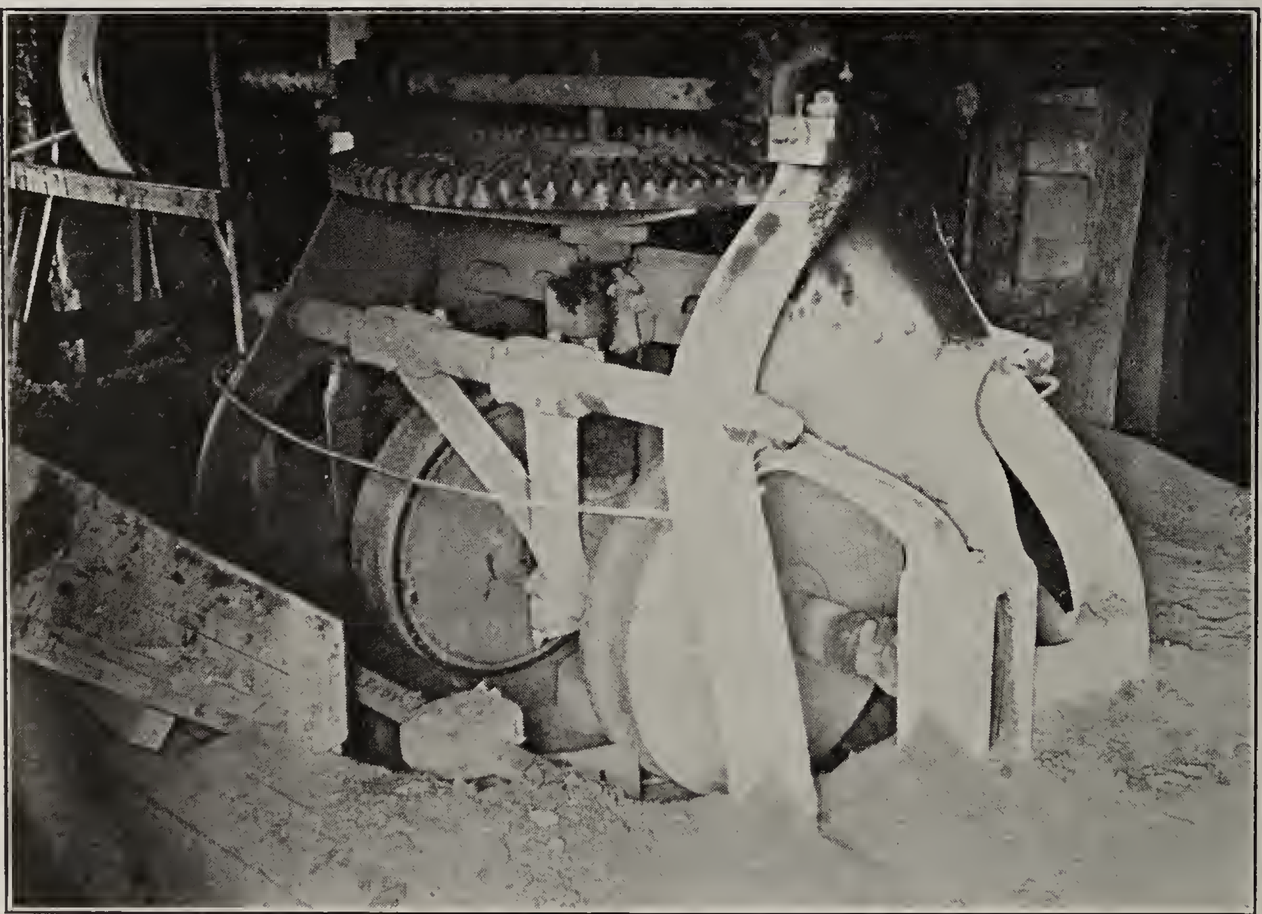
The workman in testing for moisture takes a lump of mixed material and squeezes it in one hand. The clay gives under the pressure and moves out in places where no pressure is on its surface. The workman must remember each time how hard he had to squeeze last time or the day or week before.

Now if the clay were held in a container and subjected to the pressure of a plunger or needle the plunger being quite heavy and a constant weight, the distance penetrated by the plunger would be a measure of the moisture content.

Testing moisture content

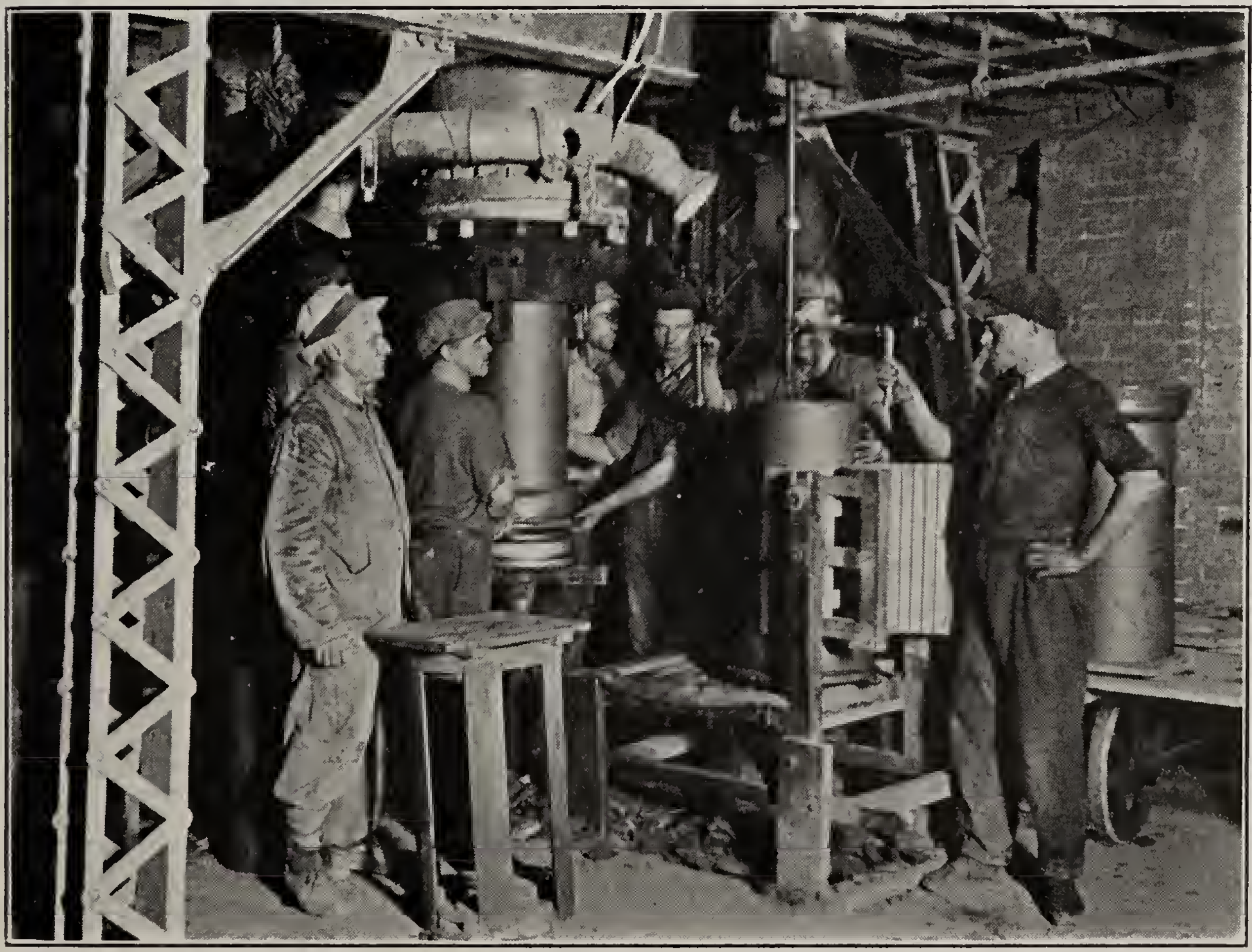
This could be compared with the lump of clay held in the workman's hand. He squeezes it. One might say the fingers were acting as a container and the workman was measuring the force necessary to press his thumb into the clay a certain distance. We could replace the thumb by a plunger, the fingers by a cup and measure the distance a constant pressure would press the plunger into the clay in a given interval of time.

Clay storage room, Hamilton, Ont.



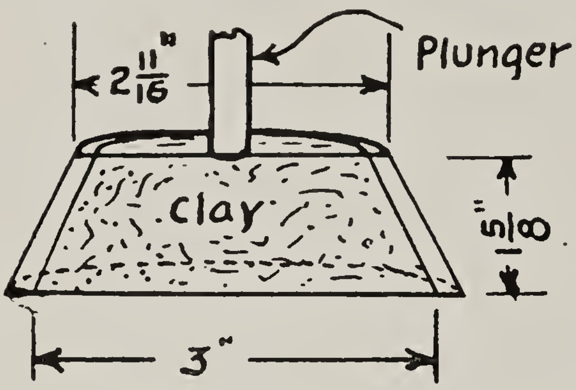
Dry Pan, Ontario Sewer Pipe Co., Ltd.

Sewer Pipe press, Dominion Sewer Pipe Co., Ltd., Swansea.



Sewer pipe press, Mimico, Ont.

An Olsen needle penetration machine was secured and a series of tests were made to determine the relation between penetration and moisture contents. The experiments were as follows:



The clay is held in a mould 2 11-16 in. x 3 in. x 1⅝ in. The area of the surface of the moist clay briquette was 5.4 square inches. The area of the plunger surface 0.1176 square inches and the weight of the plunger 5 pounds.

In order to demonstrate the usefulness of this method of testing some sewer pipe clay was secured, dried at 220 degrees F. and mixed with different proportions of water. The clay sample was quickly homogenized by repeated slapping and doubling over on a slate surface. The oiled vulcanite ring was placed wide end up on a glass surface and the clay tightly packed into it. The mould and clay was then slid off the glass, turned over and placed under the needle. The needle was lowered until it barely touched the clay and clamped. Then with the weights on the plunger the clamp was released and the plunger left so for three minutes. The clamp was again tightened and a reading made on the scale, noting the penetration in three minutes. It was discovered that one could quite readily read a difference of one-quarter per cent. of water in the mix, i.e., the difference in penetration between samples containing 22.0 and 22.25 per cent. moisture was quite readable on the scale, and all samples containing 22.25 per cent. moisture gave a higher reading than any sample containing only 22.0 per cent. moisture.

Laboratory Test

Samples of tempered clay ready to go to the press were put in sealed containers and taken to the laboratory and tested. It was found that the workman's judgment was very good—see nos. 27 to 33 in table of penetrations.

Other experiments were made using the machine for measuring the ductility of bitumen. In this test the samples or briquettes all broke before a measurable distance had been indicated by the pointer on the machine.

TABLE No. 8.

Sample No.	% Moisture added.	Wt. of Plunger in Exp.	Estimated Penetration for a 5 lb. plunger.	Duration of test.	% Loss of wt. during test	Remarks.
1	15 %	2160 gms. or 4.52 lbs.	....	......	.....	Too dry to mix into a mass.
2	20.0	"	0.33	3 mins.	2.5	Very difficult.
3	20.0	"	0.44	"	2.0	" "
4	21.0	"	1.5	"	1.5	Quite difficult.
5	21.0	"	1.4	"	....	" "
6	21.5	"	1.8	"	1.5	" "
7	21.5	"	1.8	"	1.5	" "
8	22.0	"	2.4	"	1.5	Difficult to mix.
9	22.0	"	3.0	"	1.25	" "
10	22.0	"	2.9	"	1.0	" "
11	22.25	"	4.1	"	1.25	Correct moisture inside
12	22.25	"	3.7	"	1.0	these limits.
13	22.25	"	4.0	"	1.0	
14	22.5	"	4.2	"	1.5	Not difficult to mix.
15	22.5	"	4.5	"	1.0	" "
16	22.5	"	4.6	"	1.0	" "
17	22.75	"	5.6	"	1.25	" "
18	23.0	"	6.5	"	1.0	" "
19	23.0	"	5.9	"	1.6	" "

TABLE No. 8.—Continued.

Sample No.	% Moisture added.	Wt. of Plunger in Exp.	Estimated Penetration for a 5 lb. plunger.	Duration of test.	% Loss of wt. during test	Remarks.
20	23.25	2,160 gms. or 4.52 lbs.	6.1	3 mins	1.25	Not difficult to mix.
21	23.5	"	6.7	"	1.25	" "
22	24.0	"	10.0	"	1.0	" "
23	24.5	"	10.1	"	1.0	" "
24	25.0	"	12.2	"	1.25	" "
25	25.0	"	12.7	"	1.0	" "
26	30.0	"	....	10 sec's.	....	Penetrated right through plague in 10 secs. Soft mix.
27	....	"	3.1	3 mins.	....	Samples from wet pan of Dom. S.P. factory.
28	....	"	2.9	"	....	" "
29	....	"	3.1	"	....	" "
30	....	"	2.2	"	....	" "
31	....	"	2.3	"	....	" "
32	....	"	2.2	"	....	" "
33	....	"	2.5	"	....	" "
34	....	"	2.3	"	....	Dom. factory another day.
35	....	"	2.9	"	....	" "
36	....	"	2.9	"	....	Ontario S.P. factory wet pans.

Plasticity

Plasticity is the property of changing form without rupture of surface, that is, of yielding to pressure and of retaining the new form when the pressure is removed. It is the property in tempered clay which gives an easy flow through the die and which makes it possible to press it into the various forms and sizes of sewer pipe.

Various explanations are given for plasticity in clays. It is known that fine grinding increases the plasticity of a clay and yet fineness of grain alone will not give plasticity. Finely ground quartz, glass, etc., are only slightly plastic when wet and are "short," i.e., have very little cohesion. Each particle is held apart by a film of water and under pressure these particles will, to a slight extent, slide past each other and permit of deformation of shape without rupture. On drying, however, the water disappears, there is no longer any cohesion between the particles and any pressure breaks up the moulded sample.

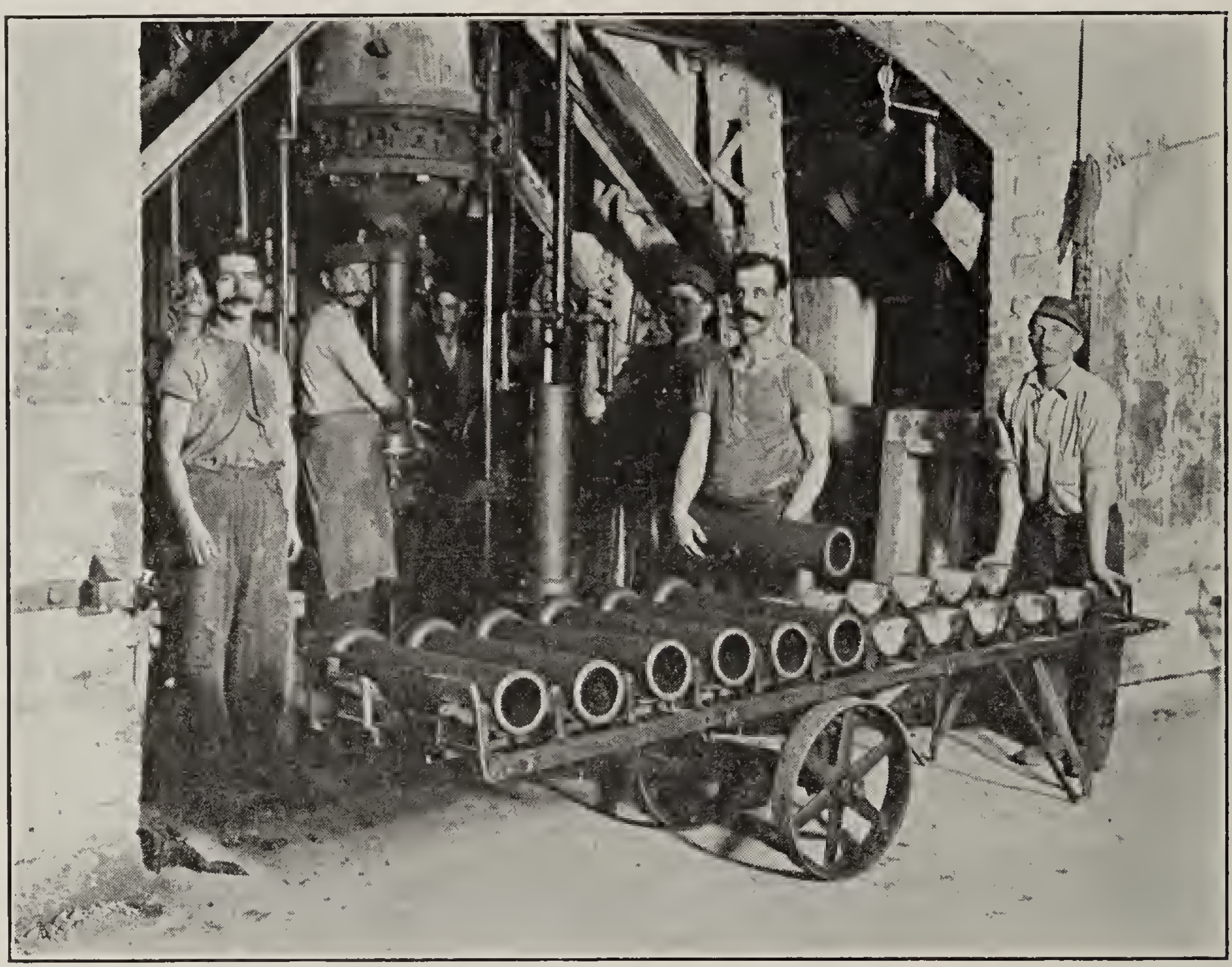
Clays are plastic and have a greater retention or capillary attraction for water than non-plastic material such as grains of sand, and, therefore, the clay grains might be said to be surrounded by a greater film of water than sand grains.

It appears that the water retained in the clay takes on colloid properties and affords a gelatinous coating to the grains which permits of a change of form without loss of close contact of the particles. Colloidal substances are also present in clay.

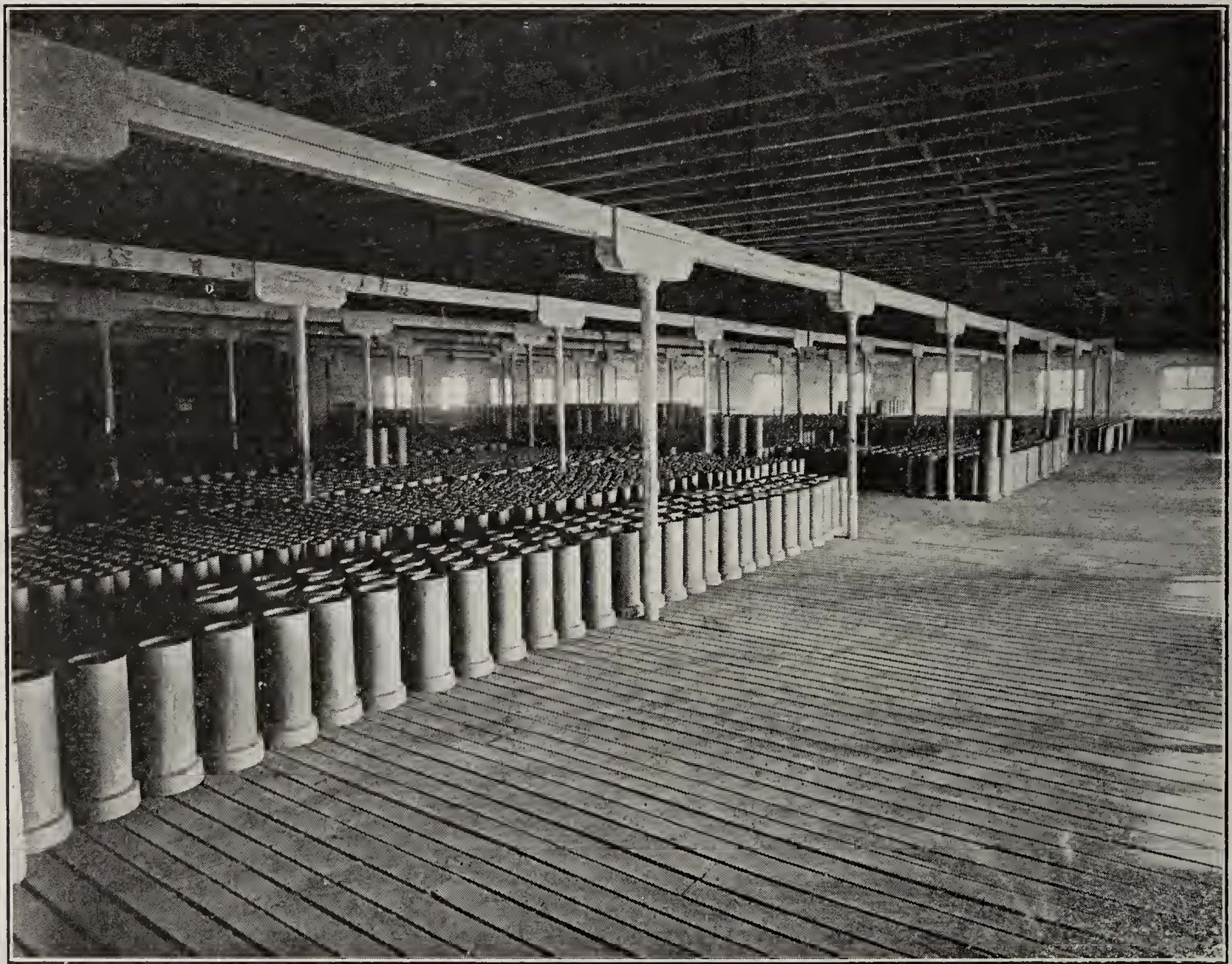
Finer grinding increases the colloidal properties of the clay and tends to make the non-colloidal grains smaller and increases the plasticity. The burning of the clay destroys the colloids and the property of plasticity, and ground burned clay is inert like sand.

Effect of sand in clay

The result of too much sand in clay is poor plasticity and a less smooth product from the press. It also lessens the cohesion in the clay of the wares on the drying floor and often causes cracking. The thinner part of the pipe or the wall of the bell dries and contracts more rapidly than the slower drying body of the pipe, and if the clay has not good cohesion the bell cracks. The lamination in the body of the pipe would also be greater and might result in slabbing and spalling in the kiln, i.e., steam would form



Sewer pipe press making 4-inch pipe, Hamilton, Ont.



Drying floor.

Drying floor, Hamilton, Ont.

Drying—half-completed pipe have been turned.

moisture or water of crystallization between the laminations and blow out in large blisters.

Ground burned clay is, however, often mixed with the clay from the store room and acts as grog to give more strength to the pipe when the temperature is near or at the point of vitrification.

The proportion of water in the clay is an important factor at the press. If the clay is too dry pressure may push it through but the friction against the sides of the die retards the outer layers more than the inner part and laminations are caused. These laminations may be disastrous later in the kiln when steam from moisture or water of crystallization forms between the layers and causes popping or slabbing.

Effect of water in clay

Effect of too much water in clay

On the other hand much water being present causes the clay to slide through the dies readily without laminations, makes the pipe too soft and plastic to be handled to the drying floor without collapsing or deforming.

The greatest possible percentage of water without weakening the pipe would be the ideal condition for compact homogeneous wares.

To obtain pipes that are compact, dense and capable of being handled before firing without deformation it is necessary to apply pressures ranging from 250 to 600 pounds per square inch as it leaves the press.

The pipe press

The sewer pipe press consists of two large cylinders and a die. To describe a typical unit the steam cylinder is 46 inches in diameter and has a piston with a 60-inch stroke. Directly under the steam cylinder is a clay cylinder which is from 18 to 24 inches in diameter. When the steam cylinder piston is fully raised the plunger is sufficiently above the clay cylinder to permit a charge of clay to chute in from a conveyer belt. The belt is stopped and the steam piston descends with a pressure behind it of 115 pounds per square inch. The lower clay piston head is only about one-quarter the area of the steam piston head and so the clay being shoved through the die is under a pressure of from 300 to 400 pounds per square inch. The die plate is securely fastened to the bottom of the clay cylinder. Inside is a steel cone and the clay is pressed between the cone and the outer circle of the die. The distance from the cone to the outer edge of the die decides the thickness of the pipe wall.

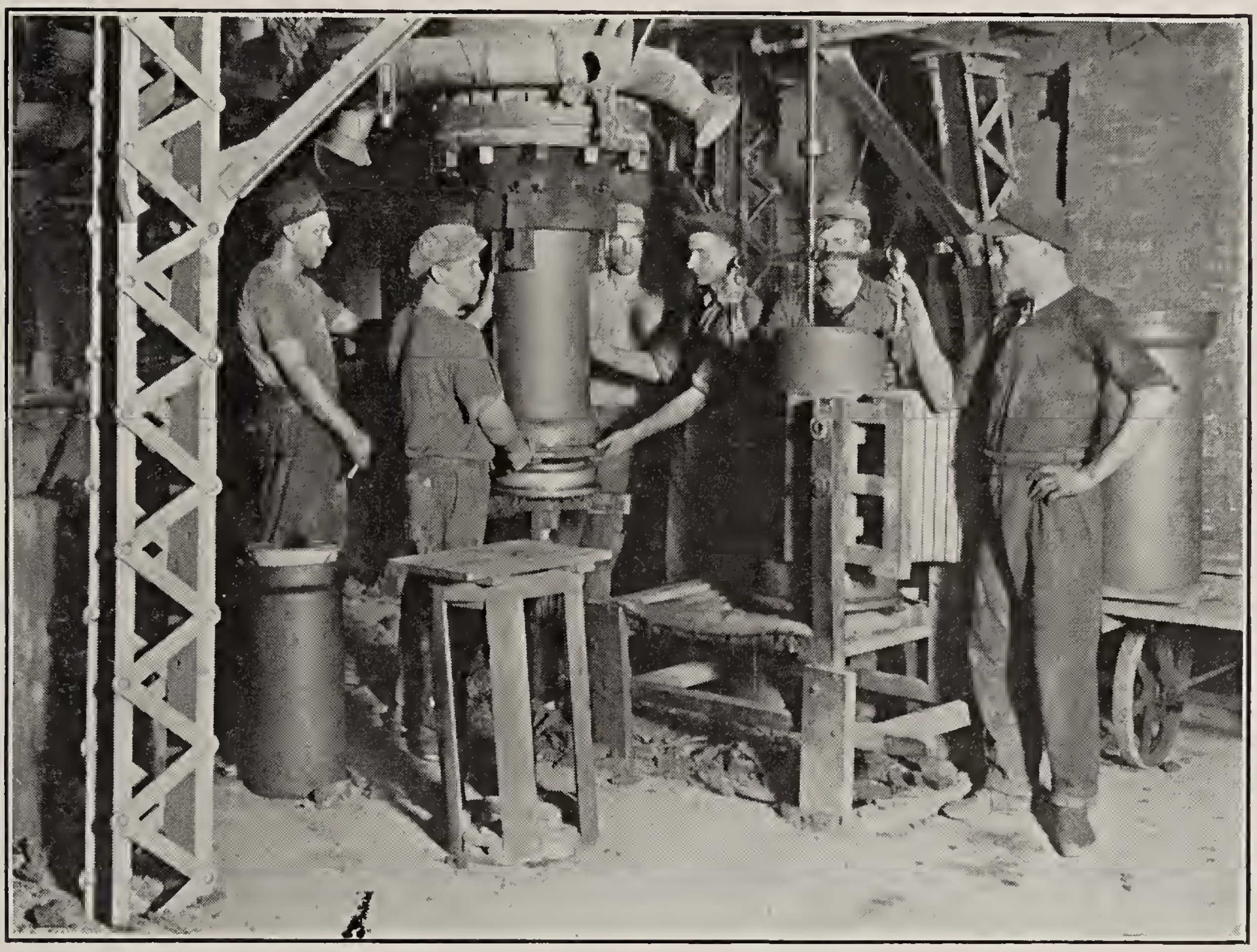
A piston from below, which is little more than counter-balanced by weight and which is operated by a foot lever, is permitted to rise. On it is the form or mould which makes the bell of the pipe. When the form reaches the die face it is clamped onto it and the steam piston is operated. Clay is pressed into this bell mould, the clamp lock is removed and the platform piston recedes as the body of the pipe is pressed through the die. When the pipe is long enough the steam pressure is cut off, a circular cutter is operated inside the die and the pipe is lifted to a small stand where it is wire cut to its correct length.

Shrinkage

In adjusting the cutter and the dies, allowance is made for the 10 or 12 per cent. shrinkage the green clay undergoes on drying and burning so that the final product shall be of given size.

The bell if thinner than the body of the pipe dries more rapidly. The shrinkage from loss of water causes the outer rim to contract faster than the more moist body and when the clay lacks the necessary cohesion and strength the bell cracks. This might be overcome in the larger pipe by enriching the more doubtful sandy clays by adding some very plastic tough clay. Any pipe in which flaws develop are scrapped and returned to the raw clay drying floor.

Each pipe from the cutting platform is placed on a wooden pallet and carried on trucks to the drying floors where it is placed bell end up.



The presses and cutter, Mimico, Ont.

Slicking up

Immediately after placing the pipe on the floor workmen supplied with damp pads or pieces of canvas slick up any rough spots. A little more care in this operation would go a long way towards producing a better looking pipe in Ontario.

Drying Floors

Steam at low pressure circulates in pipes under the drying floors. The floor boards are placed about one-half inch apart and allow an even and free circulation of heat. It is very necessary to dry all sides of the pipe evenly, otherwise they may warp or even crack due to stresses set up in the pipe. When the bell end is nearly dry the pipes are turned over and left with the spigot end up till they are ready for the kilns.

Several drying floors were visited during the preparation of this report and it appears that no proper appreciation is had of the advantage of a careful control of drying floor temperature and air humidity. Chart No. 1 has been arranged to show the moisture of air when saturated for previous temperatures. It is to be observed that air at a temperature of 98 degrees Fahrenheit will contain three times the amount of water of air at temperature of 65 degrees Fahrenheit and nearly six times as much as air at a temperature of 30 degrees Fahrenheit, above 100 degrees Fahrenheit the increase in capacity to hold moisture is most striking.

*TABLE No. 9.

Relative Humidity Table.—Pressure=29.0 inches.

Reading of Dry Bulb Thermometer.	Difference between Dry and Wet Bulbs. Relative Humidity.																								
	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	12°	13°	14°	15°	16°	17°	17.5°	18°	18.5°	19°	19.5°	20°	20.5°	21°
65 degrees	95	90	85	80	75	70	66	62	57	53	48	44	40	36	32	28	25	23	21	19	17	15	13	12	10
66 "	95	90	85	80	76	71	66	62	58	53	49	45	41	37	33	29	26	24	22	20	18	17	15	13	11
67 "	95	90	85	80	76	71	67	62	58	54	50	46	42	38	34	30	27	25	23	21	20	18	16	15	13
68 "	95	90	85	81	76	72	67	63	59	55	51	47	43	39	35	31	28	26	24	23	21	19	17	16	14
69 "	95	90	86	81	77	72	68	64	59	55	51	47	44	40	36	32	29	27	25	24	22	20	19	17	15
70 "	95	90	86	81	77	72	68	64	60	56	52	48	44	40	37	33	30	28	26	25	23	21	20	18	17
71 "	95	91	86	81	77	73	69	64	60	56	53	49	45	41	38	34	31	29	27	26	24	22	21	19	18
72 "	95	91	86	82	78	73	69	65	61	57	53	49	46	42	39	35	32	30	28	27	25	23	22	20	19
73 "	95	91	86	82	78	73	69	65	61	58	54	50	46	43	40	36	33	31	29	28	26	24	23	21	20
74 "	95	91	86	82	78	74	70	66	62	58	54	51	47	44	40	37	34	32	30	29	27	25	24	22	21
75 "	96	91	87	82	78	74	70	66	63	59	55	51	48	44	41	38	34	33	31	30	28	26	25	23	22
76 "	96	91	87	83	78	74	70	67	63	59	55	52	48	45	42	38	35	34	32	30	29	27	26	24	23
77 "	96	91	87	83	79	75	71	67	63	60	56	52	49	46	42	39	36	34	33	31	30	28	27	25	24
78 "	96	91	87	83	79	75	71	67	64	60	57	53	50	46	43	40	37	35	34	32	31	29	28	26	25
79 "	96	91	87	83	79	75	71	68	64	60	57	54	50	47	44	41	37	36	34	33	31	30	29	27	26
80 "	96	91	87	83	79	76	72	68	64	61	57	54	51	47	44	41	38	37	35	34	32	31	29	28	27
82 "	96	92	88	84	80	76	72	69	65	62	58	55	52	49	46	43	40	......	37	......	34	......	31	......	28
84 "	96	92	88	84	80	77	73	70	66	63	59	56	53	50	47	44	41	......	38	......	35	......	32	......	30
86 "	96	92	88	85	81	77	74	70	67	63	60	57	54	51	48	45	42	......	39	......	37	......	34	......	31
88 "	96	92	88	85	81	78	74	71	67	64	61	58	55	52	49	46	43	......	41	......	38	......	35	......	33
90 "	96	92	89	85	81	78	75	71	68	65	62	59	56	53	50	47	44	......	42	......	39	......	37	......	34
92 "	96	92	89	85	82	78	75	72	69	65	62	59	57	54	51	48	45	......	43	......	40	......	38	......	35
94 "	96	93	89	86	82	79	75	72	69	66	63	60	57	54	52	49	46	......	44	......	41	......	39	......	36
96 "	96	93	89	86	82	79	76	73	70	67	64	61	58	55	53	50	47	......	45	......	42	......	40	......	37
98 "	96	93	89	86	83	79	76	73	70	67	64	61	59	56	53	51	48	......	46	......	43	......	41	......	39
100 "	96	93	90	86	83	80	77	74	71	68	65	62	59	57	54	52	49	......	47	......	44	......	42	......	40

*Psychrometric Tables, C. F. Marion U. S. Department of Agriculture.

*TABLE No. 10.—HEAT UNITS.

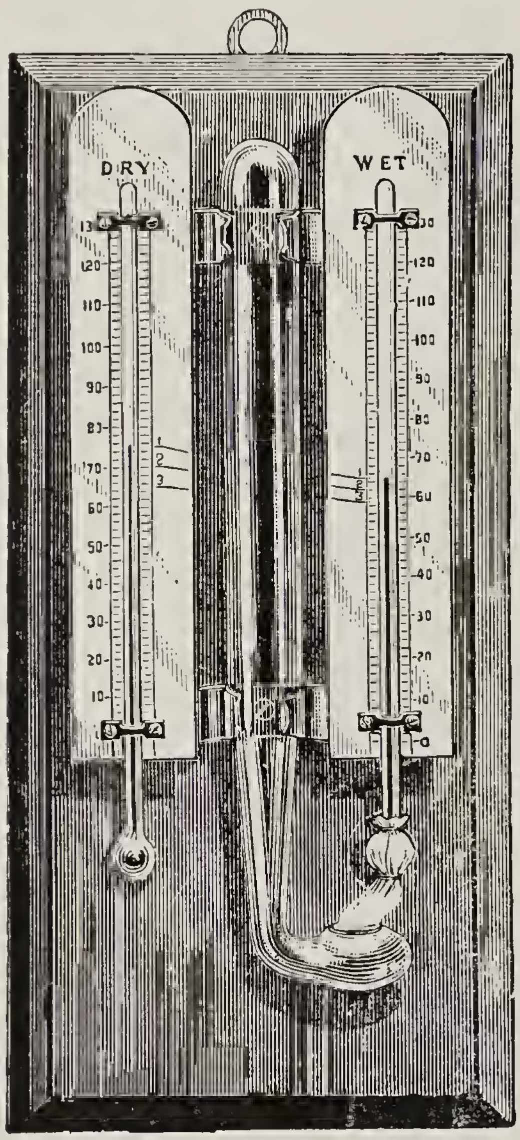
Evaporation of water.

Temperature. Degrees Fahrenheit.	Heat of the liquid.		Heat of vaporization.	
	Calories.	B.T.U.	Calories.	B.T.U.
32	0.00	0.0	595.4	1071.7
33.8	1.01	1.8	594.9	1070.8
35.6	2.02	3.6	594.4	1069.9
37.4	3.03	5.5	593.9	1069.0
39.2	4.03	7.3	593.3	1068.0
41	5.04	9.1	592.8	1067.1
42.8	6.04	10.9	592.3	1066.1
44.6	7.05	12.7	591.8	1065.2
46.4	8.05	14.5	591.2	1064.2
48.2	9.05	16.3	590.7	1063.3
50	10.06	18.1	590.2	1062.3
51.8	11.06	19.9	589.6	1061.3
53.6	12.06	21.7	589.1	1060.4
55.4	13.06	23.5	588.6	1059.4
57.2	14.06	25.3	588.1	1058.5
59	15.06	27.1	587.6	1057.6
60.8	16.06	28.9	587.0	1056.6
62.6	17.06	30.7	586.5	1055.7
64.4	18.06	32.5	585.9	1054.7
66.2	19.06	34.3	585.4	1053.8
68	20.06	36.1	584.9	1052.8
69.8	21.06	37.9	584.4	1051.9
71.6	22.06	39.7	583.9	1051.0
73.4	23.06	41.5	583.3	1050.0
75.2	24.06	43.3	582.8	1049.1
77	25.05	45.1	582.3	1048.1
78.8	26.05	46.9	581.8	1047.2
80.6	27.05	48.7	581.2	1046.2
82.4	28.05	50.5	580.7	1045.2
84.2	29.04	52.3	580.2	1044.3
86	30.04	54.1	579.6	1043.3
87.8	31.04	55.9	579.1	1042.4
89.6	32.04	57.7	578.6	1041,4
91.4	33.04	59.5	578.0	1040.4

*Arranged from Peabody "Steam and Enthropy tables."

In the rapid artificial or factory drying of ware, advantage is taken of the phenomena that is exhibited by the wet and dry bulb Hygrometers. A moist and dry body in the same room will have two different temperatures, the difference in temperature being both a measure of the rate of evaporation from the wet body and the relative humidity of the air. If the air is saturated no evaporation takes place and hence both bodies register the same temperature, and on the other hand when the wet body becomes dry no evaporation can take place and hence same temperature is registered. The laboratory apparatus is quite simple and is as shown in the photograph. The relative humidity for temperature ranging from 65 degrees to 95 degrees Fahrenheit is shown in Table No. 9.

Humidity measured by Hygrometers



The difference in the temperature of the bulbs of the Hygrometer may be used to determine the heat required for the evaporation of the moist wares since the heat extracted which is shown by the difference of temperature is the heat used in evaporating the moisture.

To state a problem.

A drying floor 100 x 70 feet x 9 feet high, has on it an average of 80 lbs. of wet stock per square foot of floor area or approximately 230 tons of pipe.

The moisture content of the pipe =22 per cent.

Temperature outside air =50 degrees F. relative humidity =80 per cent.

It is required to find the amount of coal required (1) to dry the pipe and the air; (total heat required). (2) To determine the size of blower required for circulating air—assuming the stock requires to have 50 per cent. of the moisture reduced in three days.

To solve the problem some room temperature must be determined on—say 90 degrees F.

To find the amount of moisture 1,000 cubic feet of air at 90° F. will absorb:
Air introduced to heater 50° F. relative humidity 80% referring to Chart No. 1, 50° F.

Water content at saturation = .6 lbs per 1,000 cubic feet.
50° F. water content 80% saturation = .48 lbs. per 1,000 cubic feet.

In order to dry rapidly a dry atmosphere is essential, assume 72% at 90° F.
Water content at saturation = 2.25 lbs. per 1,000 cubic feet.
Water content 72% saturation = 1.62 lbs. per 1,000 cubic feet.
1.62 — .48 = 1.14.

Each 1,000 cubic feet of air taken in at 50° F. humidity 80% and raised to 90° F. and kept at 72% saturation will carry an extra 1.14 lbs. of water.

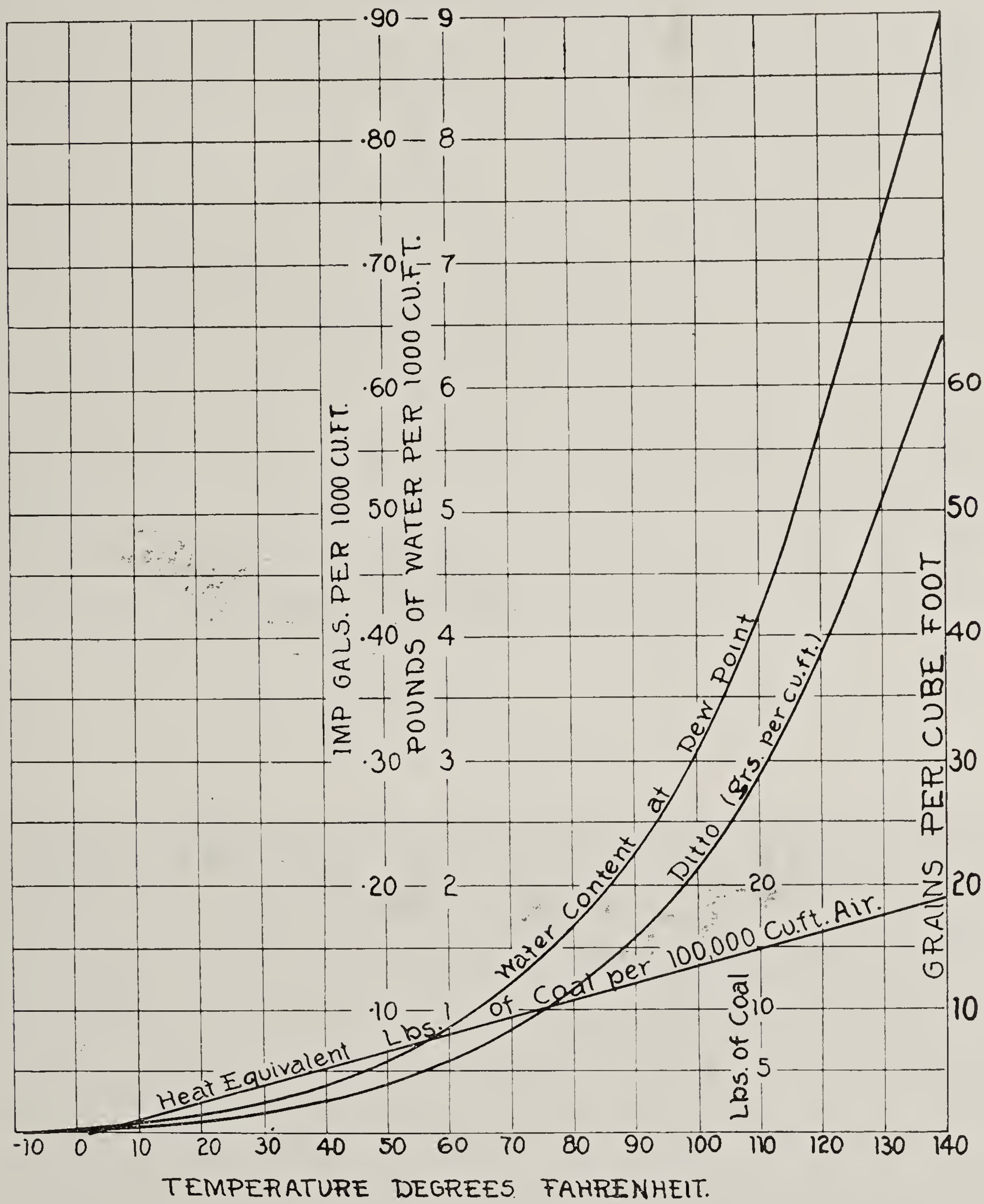
Total amount of moisture = 50% of total moisture = 11% of 230 tons = 25.3 tons or 50,600 pounds.

$$\frac{\text{50,600 weight of water}}{\text{1.14 capacity of each 1,000 cubic feet of air.}} = \text{43,400 x 1,000 cubic feet.}$$

The room contains 63,000 cubic feet.
3 days are allowed for drying.
∴ capacity of blower must equal:

$$\frac{\text{Total volume cubic feet}}{\text{Number of minutes}} = \frac{43,400 \times 1,000}{4,320} = \text{approximately 10,000 cu. ft. per minute.}$$

Such a blower would change the air of the drying room once in 6.3 minutes and would require about a 3 h.p. to operate.



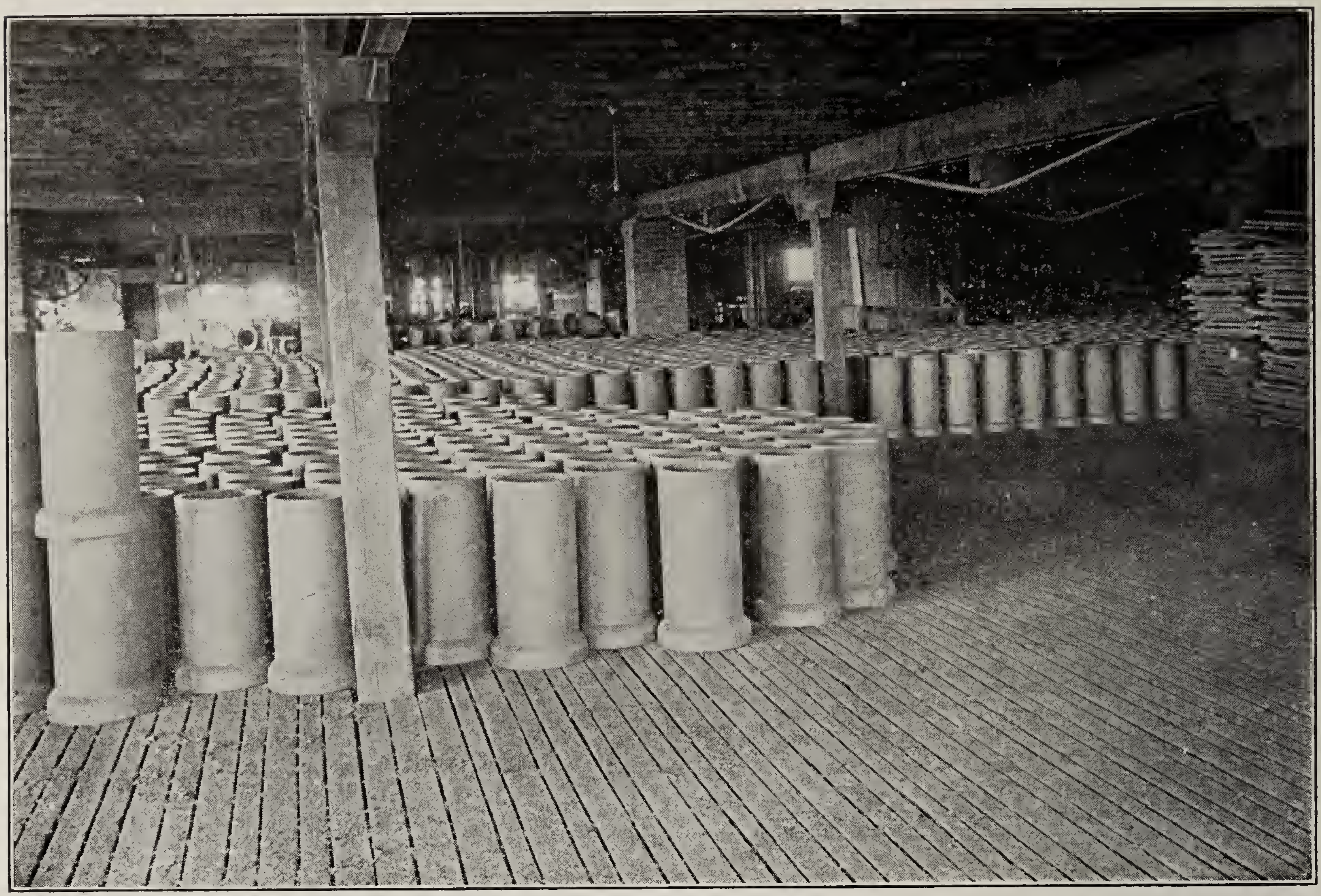
Heat required for air 43,400,000 of air from 50° F. to 90 F. referring to Chart No.1.
Heat equivalent 100,000 cubic feet air at 50° F. = 7 lbs. coal.
Heat equivalent 100,000 cubic feet air at 90° F. = 12.5 lbs. coal.

require difference 5.5
434 x 5.5 = 2,380 lbs. Approximately 1 ton, 380 lbs.

Heat required for evaporation of the water.

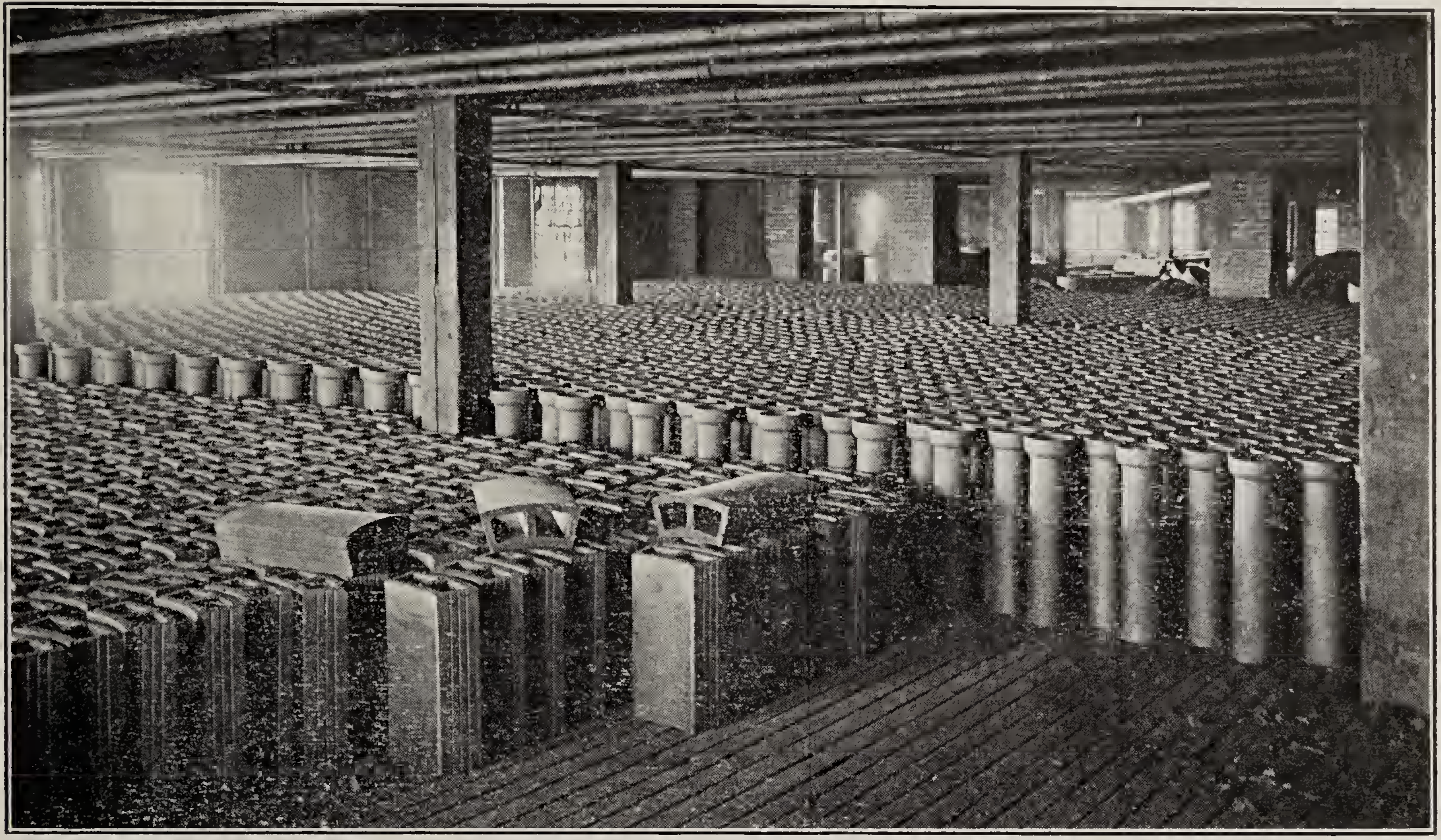
Table No. 9 indicates the temperature of the wet pipe to be in the neighbourhood of 80° F. That is about 10° lower than the room temperature owing to the rate of evaporation. Referring to Table No. 10 at 80° F. the

Heat of evaporation = 1,046.2 B.T.U. per 1 lb. of water.
1 lb. of coal = approximately 13,000 B.T.U.
Therefore, 1 pound of coal will vapourize 12.4 lbs. of water assume 50% efficiency.
1 lbs. of coal = 6.2 lbs. of water.



Drying floor Ontario Sewer Pipe Co., Ltd.

Twenty-four-inch pipe on drying floor, Mimico, Ont.



Segment block and 4-inch pipe on drying floor, Mimico, Ont.

Brick kiln under construction, Rymal, Ont.

$$\frac{\text{Total weight of water } 50,600}{\text{Weight for each pound coal, } 6.2.} = 8,160 \text{ lbs.} = \text{approximately 2 ton, 160 lbs.}$$

Heat required to raise temperature of ware from 50° F. to 90° F.

Specific heat of clay = approximately .2.

230 tons = 46,000 lbs. raised 40° F.

= 46,000 x 40 x .2 B.T.U. = 368,000 B.T.U.

1 lb. of coal = 13,000 B.T.U. Therefore, 28 lbs. of coal required.

Heat required to cover radiation losses.

3 days. Outside temperature 50° F.

Assume heat lost in B.T.U. per square foot of surface per hour, per degree difference of temperature = .10 (average figure).

Total surface = 2 (100 x 70) + 2 (70 x 9) + 2 (100 x 9).

= 17,060 square feet 75% only exposed to difference of temperature = 12,795 square feet.

Loss per degree temperature difference = 1,279.5 B.T.U. Approximately 1-10 lb. of coal per hour degree difference of temperature—say difference = 90 — 50 = 40° difference for 3 days. Total coal required = 40 x 1-10 x 3 x 24 = 288 lbs.

Answers.

(1)	Percentage of total.	Coal consumed.
(*a*) Heating in 3 days	34.70	1 ton, 380 lbs.
(*b*) Evaporating water	60.70	2 ton, 160 lbs.
(*c*) Loss by radiation	4.2	288 lbs.
(*d*) Heating wares	.4	28 lbs.
Total	100.00	3 ton, 856 lbs.

(2) Capacity of blower 10,000 cu. ft. per minute. Probable horse power, 3 h.p.

Manufacturers should keep a record of the humidity in the various parts of their factories where drying is being done, using the information to regulate the drying and to obtain improved efficiency from the floors, the photographs on plates No. 6, 7, 8 and 9 show typical arrangements. Window space should be at a minimum on account of their high radiation losses.

Table No. 11 shows the results of numerous observations and the advantage which may be had by the use of some simple instrument as the Hygrometer.

After the very careful selection of clay in the field, the most important step in pipe manufacture is the thorough and correct vitrification of the wares. This is carried out under down-draft circular arched roofed kilns. The kilns with their straight wide-walls and domed roofs are often as large as forty feet in diameter. They are built in such a way that the hot gases from the eight or more fire boxes in the walls of the kiln are thrown by the back of the fire boxes or bag-wall against the roof. They then circulate down through the green pipes and out through the checkered fire-brick floor to the flues beneath and up through the stacks. The fire-boxes and flues are built so that all parts of the kilns receive approximately the same heat, also the wares are arranged in the kilns to obtain the same result, giving a uniformly vitrified product. When the kilns are full the door-way is built in with bricks, all chinks are carefully closed up and the kiln is ready for firing.

Treatment in the Kiln

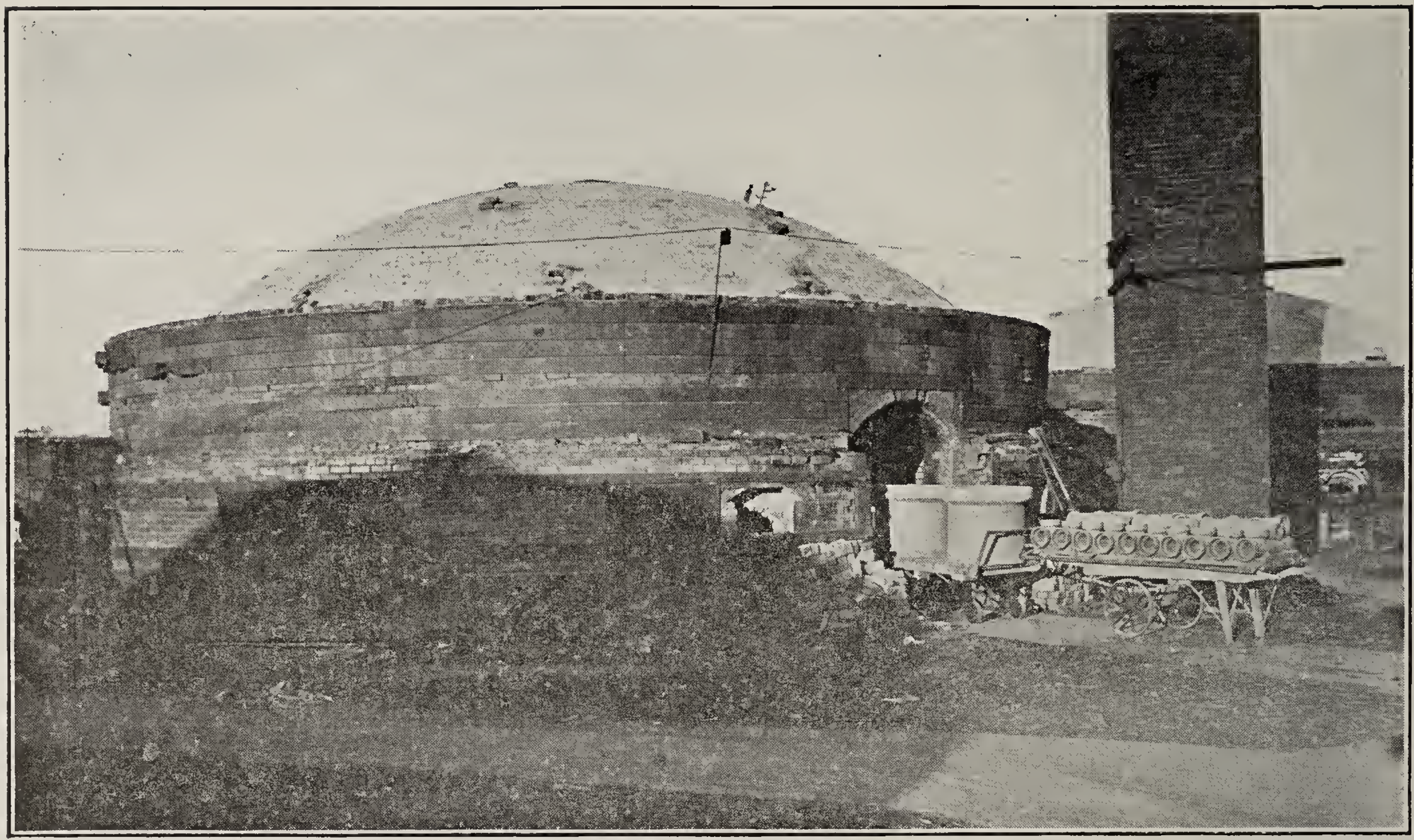
The expert burners use three methods for following the course of the burning. (1) An electric thermo-couple which is placed in the kiln, is attached to a recording pyrometer which draws a chart of the temperatures in the kiln. (2) Seger cones placed at strategic points in the kiln and extracted at regular intervals also give a record of the temperatures and show the point at which vitrification is complete and the pipes ready for salt glazing. (3) Small samples of the same clay as the

TABLE No. 11.

TABLE OF HUMIDITY READINGS ON FACTORY DRYING FLOORS

Factory.	Floor.	Room Temp.	Wet Bulb.	Difference.	Humidity.*	Pipe Temp.	Room Minus Pipe Temp.	Pipe Wet or not.	Time	Location.	Remarks.
		° F	° F	° F							
Ontario.........	1st	76	64	12	52	—	—	—	6.15 p.m.	Office	
"	1st	76	66	10	59	—	—	—	6.45 p.m.	Centre	Floor well covered with damp pipe.
"	1st	76	67	9	63	70.7	5.3	Damp	9.00 p.m.	"	
"	1st	75	65	10	59	—	—	—	6.20 a.m.	"	
"	2nd	88	71	17	43	88	0	Dry	7.00 p.m.	"	
"	2nd	87	72	15	48	85.5	1.5	"	9.20 p.m.	"	All pipe nearly dry.
"	2nd	87	71	16	45	—	—	"	6.30 a.m.	"	
"	3rd	83	70	13	52	82.8	0.2	Near dry	7.15 p.m.	"	
"	3rd	84	71	13	53	—	—	"	9.40 p.m.	"	
"	3rd	84	69	15	47	75	9.0	Quite damp	7.30 p.m.	West wing	One half pipe dry, remainder damp.
"	3rd	81	68	13	51	—	—	Near dry	6.40 a.m.	Centre	
"	4th	85	69.2	16.8	42	72.4	12.6	Quite wet	7.45 p.m.	"	
"	4th	82	68	14.0	49	70.7	11.7	"	8.15 p.m.	West wing	
"	4th	83	69	14	49	72.6	10.4	"	10.00 p.m.	Centre	Mostly quite damp.
"	4th	83	70	13	52	—	—	—	7.00 a.m.	"	
Average	....	82	....	....	52	....	....	....	....		
"	Outside	39	36	3	76	—	—	—	7.15 a.m.	....	Average humidity in factory 52°
Dominion	1st	79	76	3	87	77	2	Damp	....	West wing	
"	1st	79	76	3	87	76.4	2.6	"	....	Centre	
"	2nd	87	72	15	48	84.5	2.5	Half dry	....	West wing	Drying floors not nearly full.
"	2nd	80	70	10	61	—	—	—	....	Centre	
"	3rd	77	71	6	75	72	5.0	Half dry	....	West	
"	3rd	76	71	5	78	—	—	—	....	Centre	
"	4th	78	73	5	79	74	4	Damp	....	West	
"	4th	77	73	4	83	74	3	"	....	"	
"	4th	86	71	15	48	—	—	Dry	....	Centre	Just taken to kilns.
"	5th	86	73	12	57	83.5	2.5	Near dry	....	"	About ready to take to kilns
"	5th	87	72	15	48	—	—	—	....	"	
"	5th	82	76	6	76	77	5	Damp	....	West	
"	5th	82	75	7	72	—	—	"	....	"	
Average	....	81	....	....	69	....	....	....	....	....	
"	Outside	65	61	7	67	—	—	—	....	....	Average humidity in factory was 69°

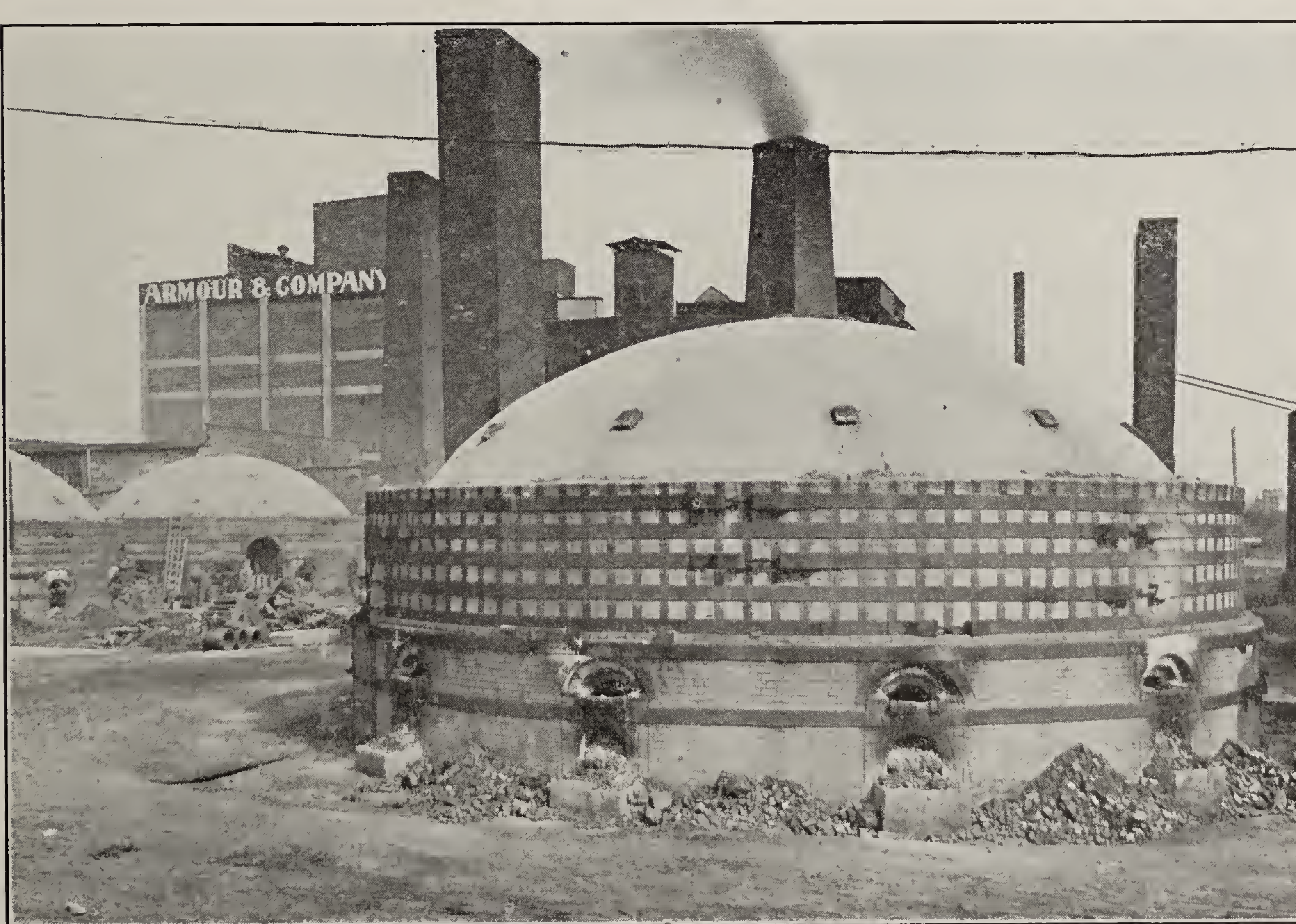
*Humidity is reported here as per cent. of saturation at the noted temperature.



Setting green pipe in kiln, Mimico.

Interior of kiln, Mimico, showing setting.

View showing several kilns, Hamilton-Toronto Sewer Pipe Co., Ltd., Hamilton, Ont.



Sewer pipe kiln, Hamilton, Ont.

pipes are put in similar positions to the Seger cones and by extracting these samples at correct intervals the course of the burning is followed. Deep holes are left in the dome of the kiln which permit the operator to watch his wares during this operation.

There are four distinct steps in the burning of the clay products, the water smoking, burning, salt glazing and cooling.

Although the pipes that are piled in the kilns are supposed to be perfectly air dried, there is always a certain quantity of moisture and water of crystallization present and this has to be gotten rid of before applying high temperature to the wares.

Water Smoking

In burning sewer pipe the term "water smoking" usually refers to that period during which any residual moisture from the drying floor process and water of crystallization is driven off. The fires are kept quite low till the burner knows that he has dried out his wares. During this period the interior of the kiln is very smoky and not until all the water has been driven off does the kiln clear sufficiently to see into it. The heat from the fires accumulates in the kilns and as the temperature rises after the water-smoking, and the contents of the kiln become red hot the kiln gases are so clear that one can see to the floor of the kiln and note the condition of the pipe.

The water present as moisture could be driven off at about 220 degrees F. or a little over boiling point, but the water of crystallization or combined water in the clay would not be completely removed till a temperature of 1,200 or 1,300 degrees F. had been reached. If there is demand for drying floor space and the pipe are put into the kiln before they are well air-dried there is an excess of moisture to be driven off in the kiln. If the heat is raised suddenly before the completion of the water-smoking there is a danger of forming steam between the laminations in the pipe faster than it can freely escape. These pockets of steam expand with increase of temperature and with bad firing the pressure becomes sufficient to blow and cause cracks or blisters which destroy the value of the pipe. Speeding the process usually results in poor coloured, scummed and blistered pipes. The forced drying seems to leach out to the surface soluble salts that otherwise would remain in the body of the pipe.

Depending upon the size and thickness of the wares, water-smoking takes from one to two days.

The temperature is gradually rising during the process and when water-smoking is complete the operator can see the floor from the peep hole in the dome of the kiln and the fires have been built well upon the grates. Just so soon as the contents are red hot from top to bottom there is little danger in raising the temperature. It is then quickly raised.

Vitrification

The water of crystallization is driven off as the temperature rises. Then at a higher temperature the carbonates present in clay decompose and give off carbon dioxide. If the clay wares were cooled at this period of the burning they would be found to be quite porous and more or less like the clay in flower pots. At this stage there has been very little knitting between the grains of clay.

As the temperature rises a point is finally reached when the edges of the clay drains start to soften. This is called insipient vitrification. At a still higher temperature the clay fuses and become liquid. This would be the point of fusion. Now somewhere between the points of insipient vitrification and fusion is the correct place to stop the burning. The temperature range between these points is called the range of vitrification of the clay.

The term "vitrification" is quite lightly used, although most manufacturers appear to appreciate the technical limitation of the term.

With some clays this "range" or interval between the temperatures of insipient vitrification and fusion is quite wide—say 200 or 300 degrees F., while with other clays the range is very narrow, i.e., so narrow that a burner could not possibly control his fires sufficiently to thoroughly vitrify his wares. He might draw test pieces from the kiln and decide that his wares were vitrified, and before he could complete his salting the wares would have fused, softened and collapsed. The distorted mass in the kiln would be broken up with crow-bars and scrapped.

In the regular process of vitrification as the temperature of the clay rises above the point of insipient vitrification the clay grains partially soften and blend into each other till the mass is no longer made up of individual crystals lying beside each other, but is massive and homogenous in formation. The interstices between the grains become smaller as the clay nears the point of fusion.

It has been variously stated and is approximately true that as the proportion of fluxes in a clay increase the melting point is lowered. It is often found, however, by actual practise and observation that two clays having about the same chemical analysis may have widely different physical properties, such as plasticity and range of vitrification. These physical properties depend on the physical as well as the chemical characteristics of the clay. Small samples collected and chemically analysed serve only as preliminary guides. Even small samples made up and burned in experimental or factory kilns may give misleading results. It is only when large samples are used and put through the regular factory process and burned as regular products that the true character of the clay for that particular ware is shown.

To determine the suitability of a clay it is important that its behaviour for each step in the process of manufacture be closely studied in the factory.

Complex silicates are formed in well vitrified clay pipe which are quite chemically inert and are not effected by the action of acids or alkalies even at boiling temperature.

Absorption and Vitrification

Soft burned pipe will absorb as much as 14 per cent. of water while a pipe burned to the point of fusion would have no absorption. It would be as dense as glass. The absorption then is taken as a measure of the vitrification, and a pipe is said to be vitrified when the absorption does not exceed 5 per cent. The burner of Ontario clays to get very hard, non-porous well vitrified wares must burn them as close to the point of fusion as he dares. As a general statement it can be said that the Ontario pipes are not burned quite as hard as they might be. Some excuse for this lies in the fact that Ontario clays have a narrow range of vitrification and require very careful burning. It is not to be assumed from this, however, that Ontario pipe is either porous or has considerable absorption, as a matter of fact it is one of the best vitrified pipes on the continent.

The present improper burning lies largely in the fact first, that small size pipe are frequently mixed with the larger sizes having slightly different burning properties in the kilns; second, that in the trucking of green pipe into the kiln, and of burned pipe from the kiln, small fragments of broken pipe keep collecting on, and in, the checkered fire-brick floor, and interfere with the free passage of hot gases into the flues. Some parts may be clogged more than others and then parts of the kiln may burn the wares better than other parts. When there is not a free, clear draft to draw the smoke and vapour from the kiln, the kiln becomes clogged and

Portion of yard and factory, Dominion Sewer Pipe Co., Ltd., Swansea, Ont.

Shipping Tile by Auto Truck, Lake Shore Road.

Preparing to salt a kiln, Swansea, Ont.

Putting salt on fires to form the salt glaze on wares, Swansea, Ont.

slow and the bottom pipe are not burned or vitrified as well as they should be. A further consequence is that the operation takes longer and the products are not so uniform, well glazed or vitrified. Care in burning but one size or thickness at a time and in keeping the floors or flues in good repair are points to be watched in sewer pipe manufacture.

The operator knows from the temperature of his segar cones, his clay samples, and from the record of the pyrometer, when the temperature suitable for salt glazing has been reached. From the time when the burner first sees floor after water-smoking to the time when the ware is ready for salt-glazing is usually sixteen hours.

Salt Glazing

The salt glaze that is formed on the surface of sewer pipe is a complete sodium iron aluminium silicate that forms at a temperature of 1,800 degrees F. or over. The salt is thrown onto the fire boxes of the kiln and dissociates into sodium and chlorine. The chlorine goes up the flue and the sodium combines with the red hot almost liquid clay surface to form a glass-like silicate. The higher the percentage of sand in the clay the more readily and better does this glaze form.

The glazing is done in the following manner,—when the burning has advanced and test pieces drawn out through the peep holes show thorough vitrification, the operator takes a wheel-barrow of salt, Plate No. 11, and goes around the kiln putting a shovelful of salt and a bundle of wood on each fire hole. When he has gone the rounds twice he draws a sample out to note if the glaze is forming. Then he gives one or two more saltings, puts on a brisk wood fire to drive or sweep out the gases remaining in the kiln and leaves the kiln for about three hours. This permits all salt and fuel gases to be cleared from the kiln by air drawn through the flues. When three hours have elapsed the damper is closed and the kiln left for about twelve hours. During this time the fire doors may be opened to partially cool the kiln, then the fire boxes are completely blocked up and the kiln is left to cool slowly. This cooling and annealing takes about three days.

Annealing

Annealing is a very important step in the process. It can be seen how brittle the vitrified wares would be without annealing by examining the condition of the small samples that are taken from the kiln to observe whether the salt glaze has struck well or not. These samples cool from white hot to air temperature in ten or fifteen minutes and are extremely brittle. A slight tap with any hard object will shatter the sample. The sample is beautifully polished but is not tough. If the kilns were cooled as quickly as possible the pipes would be as brittle as the sample and would be covered with fine air checks or cracks. The slow cooling anneals and toughens the wares.

During the first stage or twelve hours of cooling the temperature is so high that no harm is done by leaving the fire holes open, but as soon as the kiln has partially cooled all points where air might possibly enter are blocked up and the cooling continue by radiation through the kiln walls.

Through the courtesy of Ontario's Agent-General in London, Mr. Richard Reid, the following information regarding the manufacture of sewer pipe in Scotland is available:

"The raw material used is a fire-clay. It is dried, ground and passed through screens varying from 8 to 14 mesh to the inch. The clay is tempered with water and conveyed to screw presses that operate much slower than the Canadian or American steam presses.* The Scotch firms turn out from the press 90-120 4-inch pipe per hour, 80-95 6-inch pipe per hour and 10-15 24-inch pipe per hour.

*This is about one-sixth the speed of the presses in Ontario.

"The wares are on the drying floor from two to eight days depending on size. Circular drawn-draft kilns like those in Ontario are used, and the burning operation varies in length from five to ten days.

"Some plants use an extra slip glaze for their wares and others do not. A typical slip glaze used is a mixture of ground glass, fine red surface clay or English pipe clay which is screened and applied in a liquid state by a spray or brush. All pipes are salt-glazed, but the slip-glaze ones have a thicker, more glassy glaze.

"They claim that any loss in the kiln depends entirely upon the management; it sometimes reaches 5 per cent."

The fire clay used in Scotch pipe fuses at a much higher temperature than is necessary for salt glazing. As a result the pipe come out of the kiln beautifully glazed, but not thoroughly vitrified. The surface of the pipe is glassy, but with the surface chipped off the body of the pipe is more or less porous and under-burned. The wares are very carefully made, are smooth, well formed, and in appearance very excellent pipe. The only factor not in their favour is that they are more porous than and not so hard as Canadian sewer pipe.

If the Ontario manufacturers were as careful to produce clean glazed, good coloured, well formed pipe as they are in Scotland we should have here pipe that would be absolutely second to none.

2.—GLOSSARY FOR USE OF INSPECTORS AND STUDENTS.

Absorption, Colour of Fractured Surface, Hardness and Tone of Ring.

Place any ten sewer pipe in a row, bell ends up, and make sure that there are no flaws or cracks in any of them. By striking them with a light hammer each will give a musical note. Arrange them from left to right so that the pipe on the left has the highest note or pitch and run down the scale till the right hand pipe has the lowest ring. Then starting with the left hand pipe break it and select a sample that weighs about 300 grammes and shows a fractured edge all around. Do the same with the remainder of the pipe and arrange the small samples in a row corresponding to their original positions. The pipe of lowest ring will be a light almost yellowish red colour and the colour will deepen as one goes up the scale till that of the top pitch will be found to be a dark red. As the shades vary from light to dark it will not be found necessary to rearrange any of the samples. The colour varies directly as the pitch. Light colour, low pitch, and dark red high pitch.

On examining these samples it will be noticed that the lustre of the cross section varies. The light red sample will be lustreless and earthy in appearance and each sample will have more lustre as the colour darkens till the last dark coloured one will have almost a metallic lustre. The lustreless sample is soft and that of metallic lustre cannot be marked by hard steel.

Take these same samples, dry them thoroughly at a temperature above boiling water and weigh them, noting the weights. Immerse them in water for eighteen hours and after blotting all surface water weigh them again. The change in weight from the dry to the wet samples will be the moisture absorbed. It will be found that the absorption is highest in the low toned, light red, lustreless sample and lowest in the high keyed, dark red, hard sample. And the absorption of the others will be evenly ranged between these two.

In testing the pipe for internal pressure it is found that the strength varies as the absorption, ring and hardness. Great strength with dark colour, high pitch and low absorption.

The claim that the sewer pipe manufactured in Ontario is of superior quality is based on the fact that they are more thoroughly vitrified than pipes imported from outside. The more thoroughly the wares are vitrified the closer they approach to the glass-like composition. The pitch is clear and high, the colour of the pipe under the glaze is dark red, the fractured surface has a metallic lustre and the absorption is a minimum.

Appearance always counts for much. It is only natural that one should prefer a dark coloured, well formed, highly glazed sewer pipe, to a lighter coloured, scummed, dull, rough looking pipe and yet it is very possible that the latter pipe may be far superior in the qualities which mean good service.

The fine appearing pipe may be good or may not. This depends on how well vitrified it is. If the clay were high in silica or sand and one that would stand a temperature of say 1,950 degrees F. the burner might start his salting when the temperature was 1,875 degrees F.

At this temperature with the sandy clay a good salt glaze would form, i.e., the wares would take on a good salt glaze at a temperature below that of thorough vitrification. If one were to break a sample of such a pipe and were to put his wet tongue against the fractured surface he would notice that the moisture was quickly absorbed. It is quite possible to have a well glazed sewer pipe that will have an absorption of 10 per cent. or more of water. It does not need any discussion to convince a person that a soft burned high absorption pipe will not resist erosion and wear so well as a hard burned pipe. The chemical change into the complex silicates has not reached completion and the pipe material will not be so chemically inert or acid resisting. The pipe may also slowly disintegrate by the freezing of absorbed water. *A hard burned pipe is close grained, hard, low absorption and chemically inert.*

One frequently encounters pipes that from the point of view of appearance are decidedly seconds or even culls, but which on closer examination have all the qualities which go with long wear and good service. Pipe is good pipe when it is uniform and symetrical in shape and is hard burned. The greyish pipe may have entered the kiln before being completely dry or may have been subjected to the sulphur fumes of a bad shipment of coal, but if the burner has held his kiln at vitrification temperature till his wares were thoroughly vitrified he has produced a pipe that falls short in appearance only. It is, however, true that carelessness at some stage of the process has produced this dull rough looking pipe, and that with more attention the pipe should have had all the qualities which make it readily marketable and acceptable.

Black Cores.

Occasionally when a sewer pipe is broken, the fractured surface will show a dark or black core between the red outer layers of the pipe. Sometimes this core will be only about one-tenth the thickness of the pipe and at other times over half the thickness. The core is the result of poor burning, and is caused by incorrect supply of oxygen in the kiln during the burning. When the flues are not drawing well there is a large supply of carbon from the coal and not enough oxygen or air to give complete combustion and an oxidizing atmosphere. The iron salts in the clay are not formed into the red ferric oxide but are reduced to the black ferrous oxide

of iron which colours the centre of the pipe wall. At a later period of the burning when the kiln is being finished the outer layer of the pipe is oxidized to the red colour, but the centre remains black. These black cored pipe are not as high grade as the clear dark red ones.

Small Cavities or Perforations in the Pipe.

In some parts of the clay areas the ground is covered with forest growth. This forest is cleared off and the large roots cleaned out, but the smaller roots penetrate quite a distance into the ground and remain there. A very light surface is scraped off and discarded and then the remainder down to where the shale and high lime start to show, is collected and sent to the factory. If the screens are out of repair some of these small roots will get into the tempering pan and will appear on the green pipes. The roots ultimately burn out and leave cavities or perforations. Of course the remedy would be more careful collection in the field and new or repaired screens.

Colour of Fractured Surface. See absorption.

Cracking.

This has been mentioned in connection with the drying of the green pipe.

Cracking depends almost entirely on the composition of the clay used. If the clay is either too lean or too fat the wares will crack.

Lean clay is that which lacks plasticity and contains too much sand or loam. To remedy cracking in a lean clay one adds some fat clay.

Fat clay is almost free from sand or loam, is wax-like when slightly moist, and breaks up into cube-like particles when freshly dug from the ground. A t o rich or fat clay is not suitable for sewer pipe because of its abnormal shrinkage. This may cause cracking when the different parts of the pipe dry unevenly. Cracking is overcome here by mixing some lean clay with the fat clay.

In practice it most often happens that right at the surface of the ground the clay is just a little loamy, and a little further down it is a little too fat. In stripping the clay these are both taken and thoroughly mixed before arriving at the press.

For preventing cracks in the wares on the drying floors it is suggested that:

*"By adding one or two per cent. of common salt ($NaCl$) to the clay in the tampering pan one can retard the too rapid drying of the surface of the wares. As the drying proceeds the salt solution exudes to the surface and deposits there a small quantity of salt. The salt is hygroscopic and does not completely dry. It keeps the outside of the wares moist till the inside has dried out. The slightly moist surface prevents cracking, as the salt is subsequently burned off in the kiln."

Discolouration and Scumming of the Surface of the Sewer Pipe.

There are three fundamental causes for scumming and discolouration. One is moisture, the second is lime and the third is sulphur. The first two may be considered together.

As a rule pipe which has not been sufficiently dried in the factory introduces an excess of moisture into the kiln. If this happens with a clay which contains a large percentage of soluble lime salts under the forced drying conditions in the

*Mr. Joseph Keele, B.A.Sc., Dominion Government Ceramic Engineer.

kiln the lime salts come to the surface and leave a deposit which is, or is converted into, calcium sulphate. These salts generally remain in the body of the pipe when the pipe is air dried or dried slowly.

The explanation given is that the soluble salts in the clay, usually calcium sulphate ($Ca\ SO_4$), are brought out to the surface in the forced drying of the oven or drying-room floor. The workmen say that the factory-dried wares dry from the inside out and the air-dried from the outside in. It is certainly true that scumming is most often caused by soluble salts in the clay and under forced drying conditions.

In some clay ware industries they add certain chemicals to a high lime clay to prevent efflourescence or scumming. Barium carbonate in the form of a powder is mixed in with the clay. The barium carbonate is not soluble in water and so to secure a very thorough and intimate contact between all the clay and all the powder, very careful mixing is necessary. The soluble salt in the clay is changed to an insoluble one which is not leached out to the surface.

Barium chloride is also sometimes added for the same purpose.

The cost of chemical treatment of the clay in sewer pipe industry is almost prohibitive. For example, if the clay contains water solubles, say one per cent., then in one hundred pounds of clay we will have one pound of scumming material, calcium sulphate ($Ca\ SO_4$). The $Ca\ SO_4$ and $Ba\ CO_3$ react chemically in the proportion of 136 to 197 or for every 136 parts of $Ca\ SO_4$ we need 197 parts of $Ba\ CO_3$. The one hundred pounds of clay mentioned above would need 1.4 pounds of $Ba\ CO_3$. An absolutely ideal mix and other favourable conditions might give this, but normal conditions would hardly give a fifty per cent. efficiency. This would mean the addition of at least three pounds of $Ba\ CO_3$ for every one hundred pounds of clay. The retail selling price of one hundred pounds of sewer pipe is approximately $1.00. This gives the cost of chemical as 7 to 9 per cent. of the selling price.

If a manufacturer decides to use barium carbonate ($BaCO_3$) to prevent scumming he should have his clay analyzed and discover just how much he will have to add to overcome the difficulty.

If the clay is high in lime but is well dried, and if the kiln is free from excess water and steam, it is still difficult to secure a good salt glaze. Sulphuric acid, formed from the small quantities of moisture and sulphur usually present in the fuel used for firing, turns the lime into the soluble sulphate which exudes to the surface of the pipe where it forms a thin coating and instead of the clear glass of sodium iron silicate forming, which is glossy and transparent, a calcium silicate forms which is yellowish and opaque. If it is necessary to use only about one part per hundred of these chemicals, with barium carbonate selling at 2½ or 3 cents per pound, the additional cost of raw material might not be prohibitive.

Glaze.

Most users and inspectors of sewer pipe seem to consider a clear dark salt glaze one of the essential characteristics to look for in selecting pipe. Emphasis is placed on the fact that the glassy salt glaze has a much lower co-efficient of friction than other surfaces used for sewer construction. It is true that well glazed pipe has a lower co-efficient friction than bricks or concrete, but it seems to be equally true that the sewage does not really come in contact with the sewer wall after a few months operation. Men who have been working at sewer construction and maintenance for many years admit that every sewer, large or small that has not an abnormally steep slope, is coated with a fine slime.

Only hard objects like pebbles, etc., penetrate this slime and come into actual contact with the sewer wall. No matter what the sewer surface, if it be covered with this lime it will have approximately the co-efficient of friction. Inequalities in the running surface like uneven joints, appear to be more important than the character of the surface of the material of construction.

If the above be the case, and each one can decide for himself, the procuring of a brilliant glaze does not seem to be as important as making a well vitrified pipe with a hard, clear ringing body. If the glaze wears off, as it may do, the hard-burned pipe which is nearly as hard and smooth as the glaze itself will wear indefinitely. A clear salt glaze is not so important as thorough vitrification.

Sulphur in the coal is greatly responsible for an inferior salt glaze and even if all other conditions are favourable, may be the cause of cutting down the glaze before the kiln has been "swept out" after salt glazing. This is especially so when the foundations or flues of the kiln, due to poor underdrainage, contains water. The presence of the water interferes in two ways, first, by checking the draft and keeping the bottom of the kiln cooler than it should be, and second, in causing an excess of water vapour in the kiln. The latter promotes the formation of sulphuric acid resulting in a damaging of the salt glaze.

If there is much sulphur and much lime and moisture present the pipes may be completely covered with a white scum. Unfortunately the sulphur formed is not burned off by the high temperature of the kiln, although it may be improved somewhat by prolonged burning.

It would pay the Ontario manufacturers of sewer pipe to buy their coal on analysis and provide for storage of sufficient coal to protect against coal shortage due to rejection.

It would also pay them to make sure that their kilns are well underdrained and make impossible the presence of water in their flues.

Summarizing—the Ontario manufacturer should be careful to select clay that contains less than 3 per cent. of lime in it, thoroughly dry it and use low sulphur coal in well drained kilns. Sewer pipe made from Ontario clays, low in lime, well dried and burned in the absence of sulphur will always take on a clear salt glaze.

Hardness. See absorption.

Lime Spots.

Sometimes soft white spots which vary in size from a pin head to a pea occur in sewer pipes. This is caused by small particles of limestone which accidentally has been mixed in the clay. It may come from the clay field in the form of pebbles or may be from an uncleaned gravel car used for clay on the railway. The soft white spot is quick lime.

These spots either wash out leaving a pit or take up water to form a calcium hydroxide which swells and causes scaling or a fracture of the pipe. Pipe containing numerous lime spots should be rejected.

The factory must exercise care in the selection of the clay and should make certain that the conveyances used from field to factory are clean. If the clay were finely ground and thoroughly mixed a small quantity of extra lime, not exceeding a total of 3 per cent., well distributed in the clay would have no effect on the quality of the finished pipe.

Mr. Keele suggests the addition of one per cent. of sodium chloride on bone dry weight of clay to overcome lime spots. It works. He also suggests a method using a reducing atmosphere in the kiln.

By maintaining a reducing atmosphere in the kiln during the early stage of the burning (which means an absence of excess of air and oxygen) the calcium carbonate is burned to lime, then the sulphur in the coal and moisture in the kiln forming sulphuric acid, attack the lime and change it into calcium sulphate. The small lime spot which is carbonate burned to the form of calcium oxide would then be calcium sulphate which does not change when exposed to air and moisture.

The method would be to cause a reducing atmosphere in the kiln a little before, at the time when, and after it reaches the temperature of the dissociation of calcium carbonate.

SCUMMING OF SURFACE. See discolouration.

RING. See absorption.

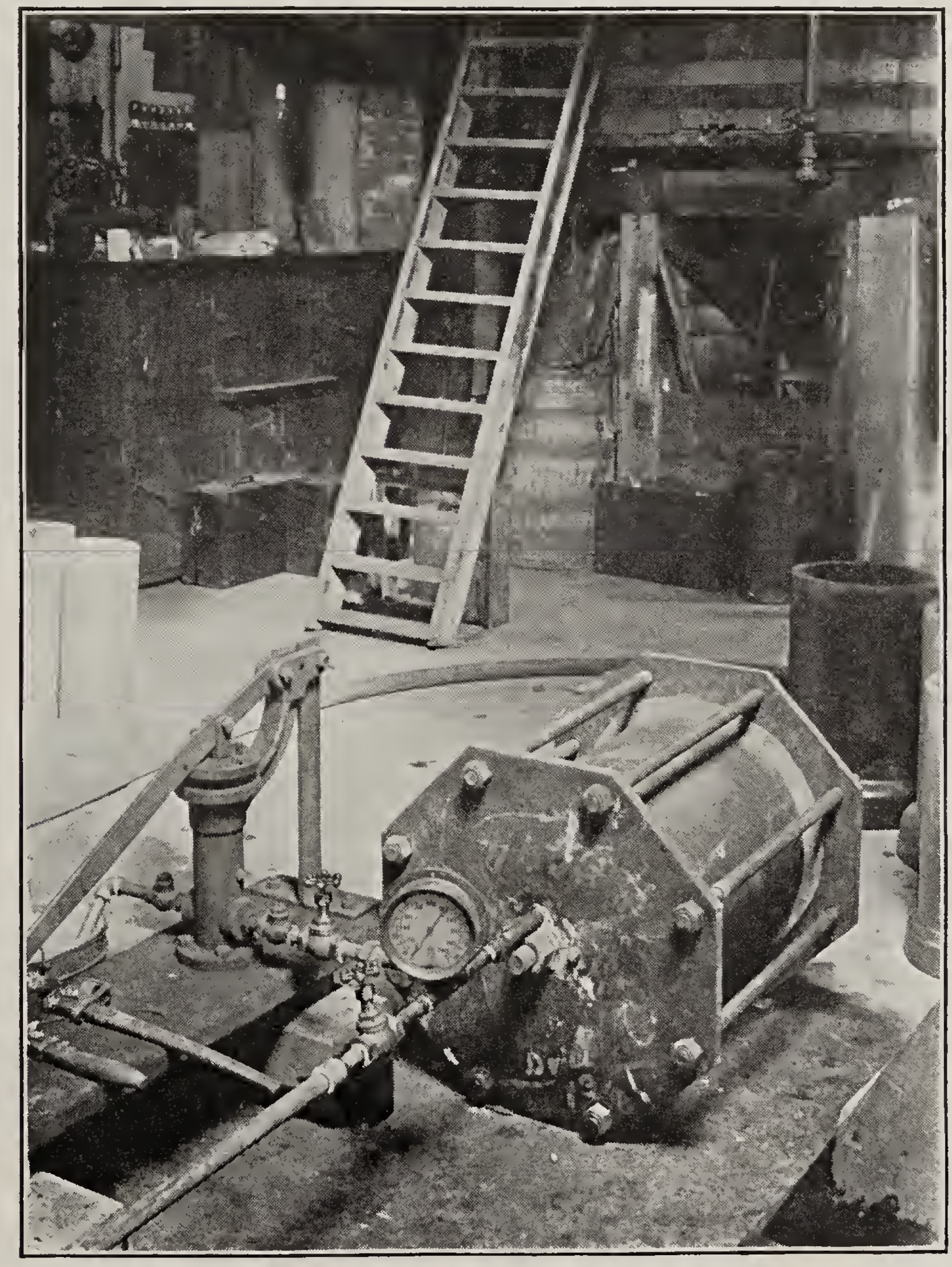
Shipping pipe, Hamilton, Ont.

3.—TESTS MADE OF VITRIFIED CLAY SALT GLAZED SEWER PIPE MANUFACTURED IN ONTARIO.

Resistance to Internal Pressure.

The physical factors which would tend to destroy a sewer pipe which had already been laid in the ground and covered over, are erosion, external pressure and internal pressure. These factors will be studied separately.

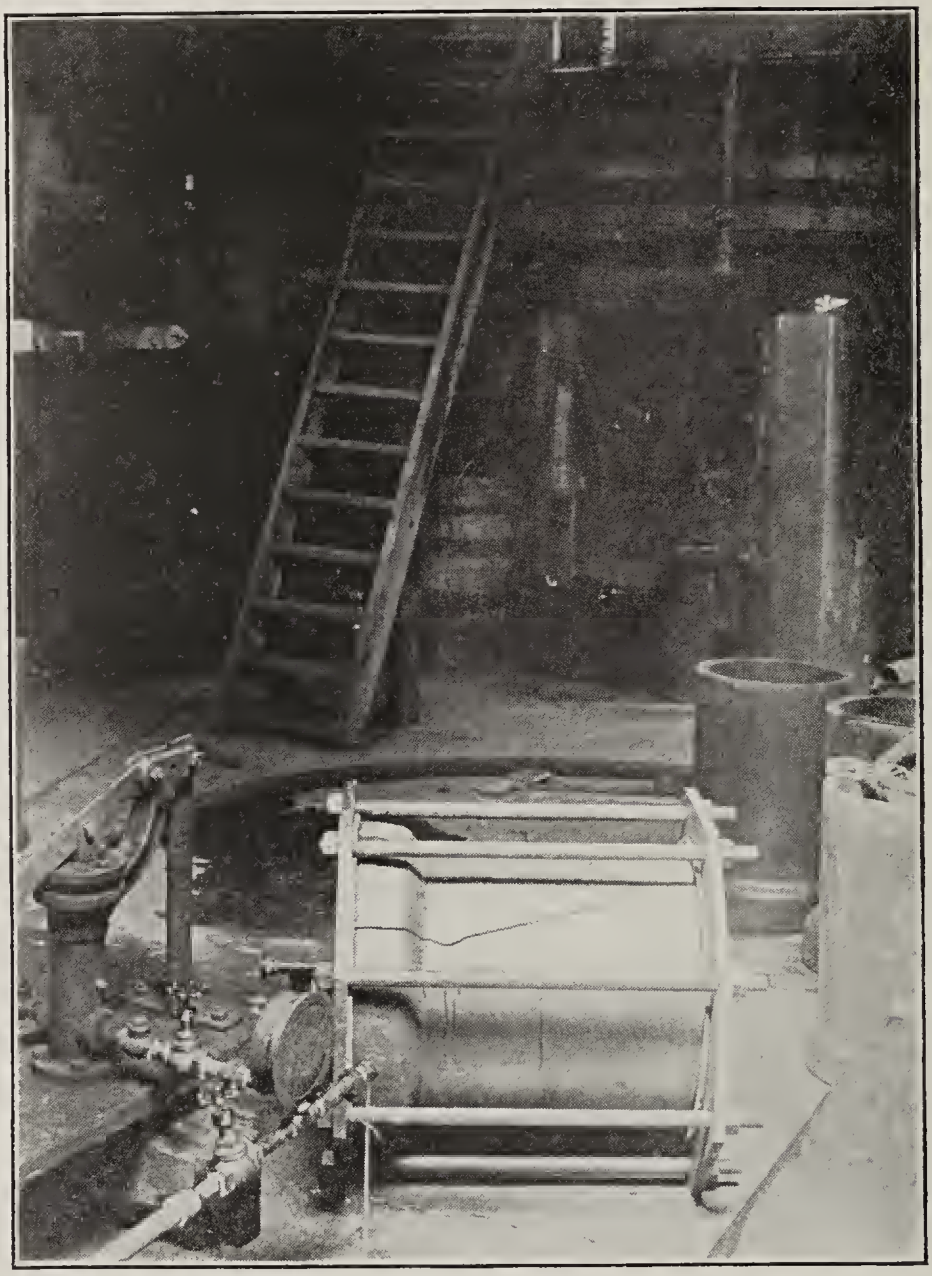
Sewer pipe are seldom subjected to very great internal pressure. All sewers should be equipped with manholes which permit of sewer inspection and act as safety valves or vents in times of flood. During storms and floods a sewer may receive more water than it can carry away and it occasionally happens that where the grade is flat or where any obstructions exist the water rises in the manholes until it either overflows or creates sufficient pressure to force the obstruction through the sewer.



Testing vitrified clay sewer pipe by internal pressure, Experimental Station, Provincial Board of Health, Toronto.

The pressure in the sewer therefore will seldom exceed the equivalent of the head produced by the depth of the nearest manhole. Even in exceptional cases this head would rarely exceed 30 feet and should not produce a pressure greater than 15 or 20 lbs. per square inch in the sewer. So if the sewer pipe will stand an internal pressure of 20 lbs. per square inch without bursting it is quite strong enough for any condition that would exist in practise. If the sewer leaks at the joints it is not a fault in the pipe but in the sewer construction.

No previous tests were available on Canadian sewer pipe and their approximate strength was not known. The testing apparatus was designed to break pipe that might test as high as 200 lbs. per square inch. The apparatus was roughly, two steel bulkheads held against the ends of the pipe by means of long bolts as is shown in the illustrations. Rubber sheets $\frac{1}{4}$ inch thick were used as gaskets between the steel plates and the pipe. One of the bulkheads was fitted with a petcock, elbow and nipple, so that when the pipe was on its side the air would be permitted to escape as the water filled the pipe. The other bulkhead was fitted with a three-quarter inch iron pipe through which the water entered.



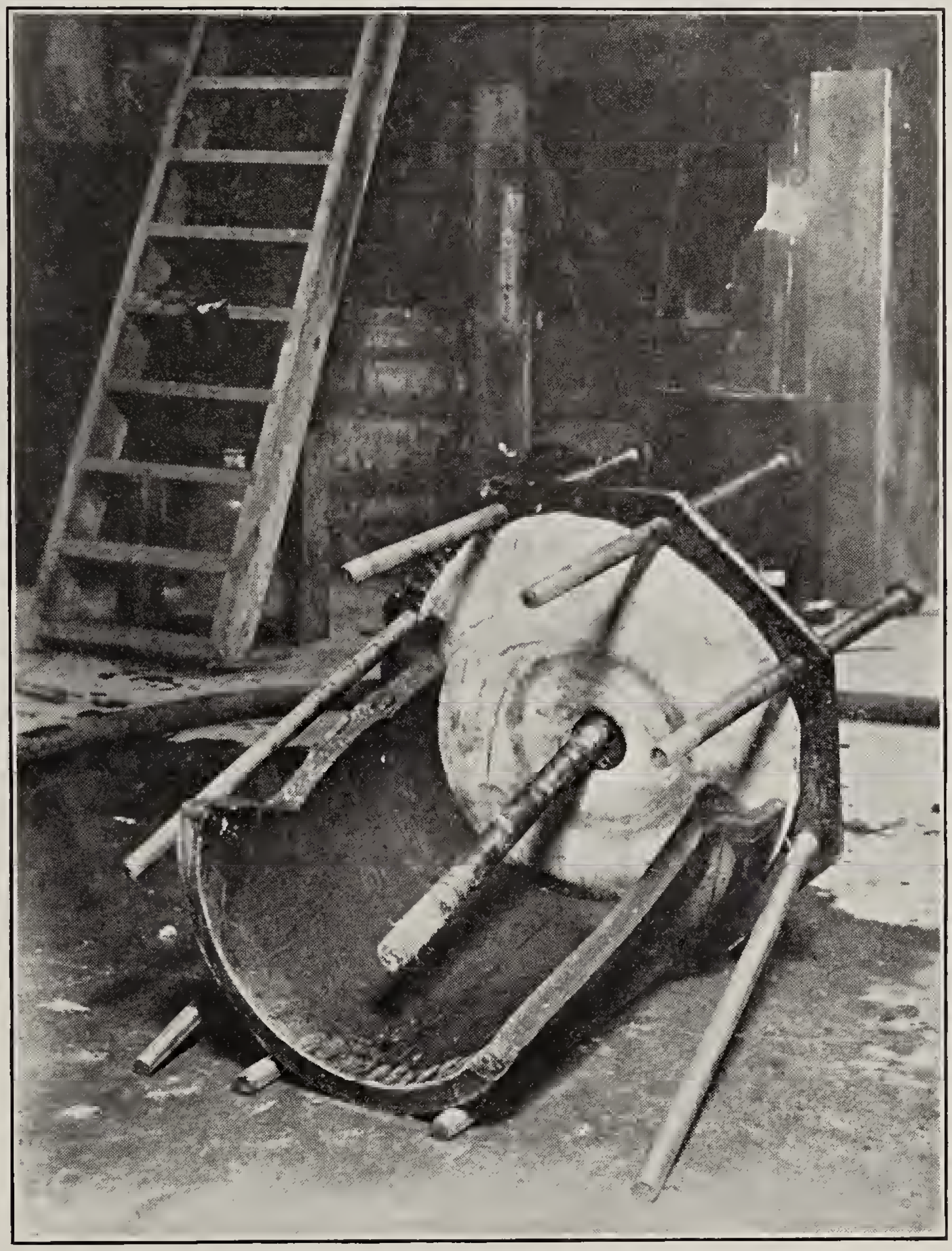
First longitudinal crack—resistance to internal pressure.

The water piping was arranged so that the sewer pipe could be filled from the city water system and broken by the pressure from a hand-pump.

In making the test one bulkhead with the eight 1-inch bolts in place was laid on the floor, the rubber gasket placed on it, and the sewer pipe stood on the rubber sheet, bell end down. The $1\frac{1}{2}$-inch centre bolt was then put in place, the other rubber gasket placed on the spiggot end of the pipe and the heavy steel bulkhead placed over it. The side bolts were slightly tightened, the pipe carefully centred and the bolts made more tight. The whole outfit was then tilted over till the sewer pipe was horizontal with the floor, care being taken that the nipple for the air exit was perpendicular. All the bolts were tightened and the water inlet coupled on. The pet-cock air vent was opened and the city water turned on and left running until at the moment when water started to run out of the air vent.

With the city water shut off and the pet-cock closed the valve of the pressure pump was opened and the pump operated. The pipe being already full of water it required very little effort and pumping to cause the pressure to rise to a point where the pipe would burst or pop. In every case the pipe broke in long cracks longitudinally and did not fly to pieces. The maximum reached by the gauge was noted and the apparatus uncoupled.

Each pipe before being tested was carefully inspected and measured and its condition noted.



Pipe brcken by internal pressure.

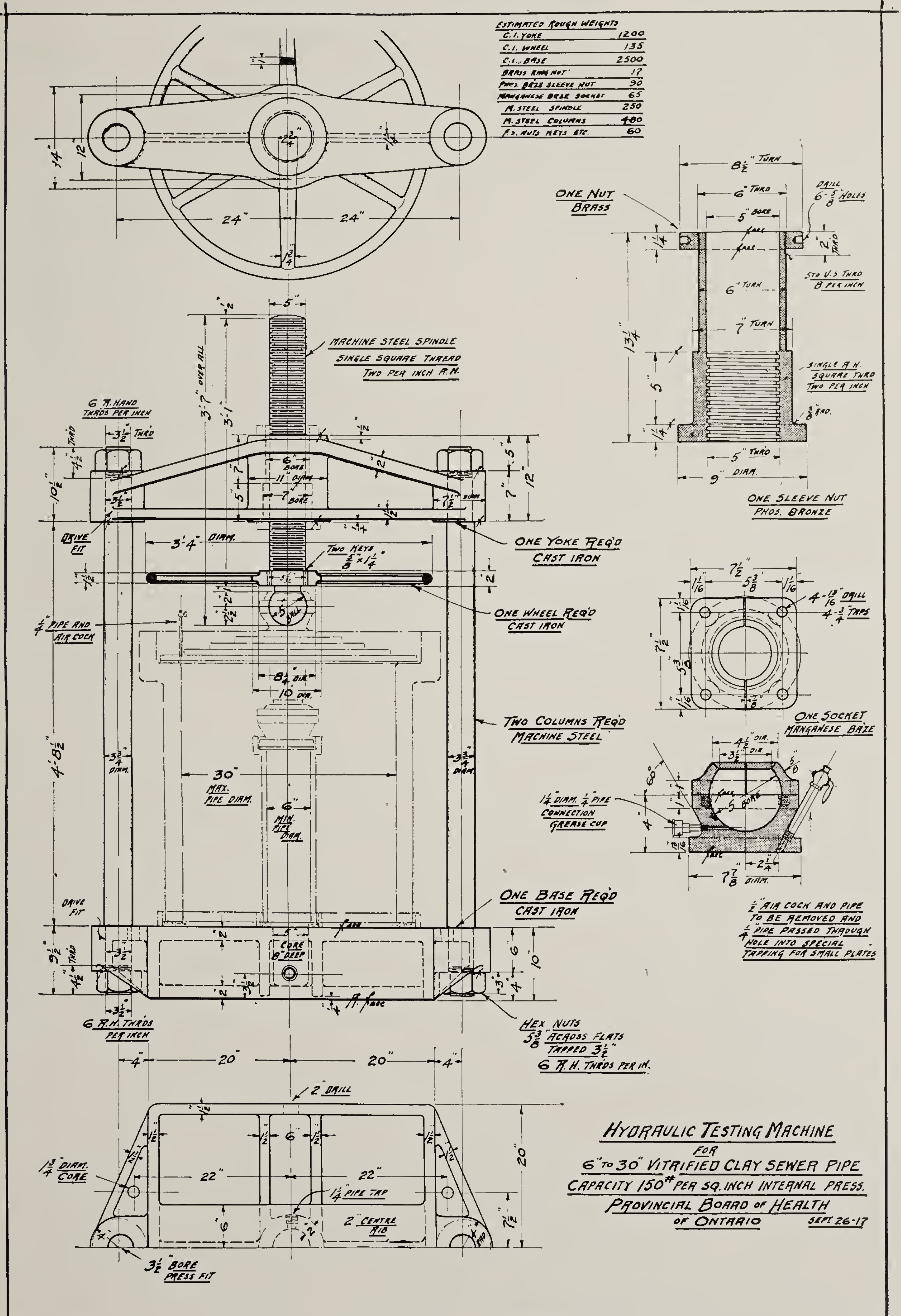
If the ends of the pipe were quite regular and even, it was not difficult to keep the rubber gaskets tight enough to prevent leaking, but if the bell end particularly, happened to be a little uneven it leaked. See photo No. 48. The pressure might run up to 80 lbs. per square inch without bursting the sample, but leakage makes it impossible to obtain any higher pressure. The bolts would be tightened and the pressure again put on, when the pipe might burst at 60 lbs. pressure. The heavy bolts and nuts would put so much strain on the bell of the pipe that it was weakened and failed at a pressure which did not show the real strength of the pipe. It is very reasonable to infer that all of the results tabulated show bursting pressures considerably lower than the true strength of the pipe.

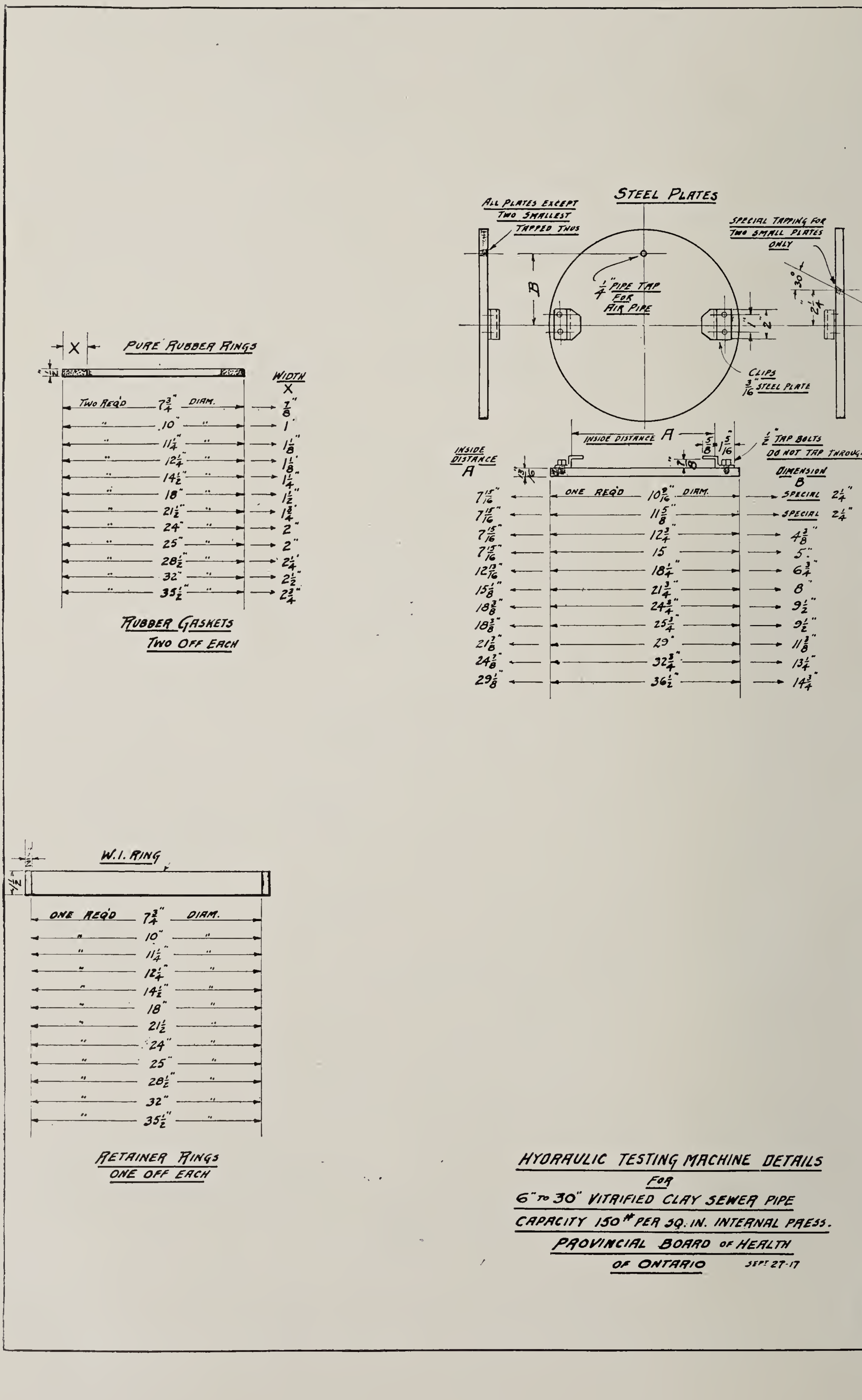
This method of testing (which is acknowledged faulty) gives to the weakest pipe tested a strength sufficient to withstand a pressure equivalent to a head of 40 feet of water. The pipes therefore are evidently strong enough for all practical purposes, and are certainly stronger than our figures show them to be. In the

TABLE No. 11.

INTERNAL BURSTING PRESSURE ON VITRIFIED CLAY PIPE.

No.	Size.	Manu-facturer.	Glaze.	Color.	Ring.	Hard or soft burned	Bursting Pressure.	Absorp-tion.	Remarks.
	inches								
1	4	Hamilton	good	dark brown	clear	medium	....	4.5	End uneven and so pressure of end bolts broke it before water was introduced.
2	6	"	"	"	"	hard	60 to 65 lbs	4.0	Good looking pipe, lacked lustre.
3	6	Ontario	poor	very light brown	very clear	"	120+	1.0	Pipe might be called a 2nd from appearance. Not smooth or well finished.
4	6	Dominion	fair	dark brown	clear	under med.	40	5.4	Several root holes. Two right through the pipe. Otherwise fair looking.
5	8	"	good	"	very clear	hard	55	1.2	Good looking, but a few cracks on the surface that do not go through.
6	8	Hamilton	"	"	clear	medium	60	5.3	Good looking, lacked lustre.
7	8	"	"	brown	"	under med.	50	5.3	Clean and well shaped.
8	8	Ontario	poor dull	light brown	"	hard	40 to 50	4.0	No polish to pipe.
9	9	"	poor	very " "	very clear	"	120	1.6	Judged by color was a 2nd. Very sound.
10	10	Dominion	"	dark brown	clear	over med.	45	3.1	Weakened by fire cracks in bell. A few root holes.
11	10	Hamilton	excellent	very dark brown	"	medium	70	4.3	Very fine appearing. Well finished and glossy.
12	10	"	good	brown	"	"	45	4.6	Good appearance. Well shaped.
13	10	Ontario	none	very light brown	"	soft	....	6.5	End pressure of bolts broke, underburned and weak bell.
14	10	"	good	dark brown	"	hard	60	1.2	Good looking pipe.
15	12	Hamilton	"	brown	"	over med.	60	4.4	Good looking pipe.
16	12	Ontario	only fair	very light brown	"	medium	37	4.4	No polish. Fire crack in bell.
17	12	Dominion	fair	dark brown	"	"	60	6.2	Dull glaze. Root cracks and holes are right through.
18	15	"	good	"	very clear	hard	65	4.5	Very rough surface. No holes. Strong looking and sound.
19	15	Ontario	none	grey	"	"	80+	3.0	Decidedly a 2nd from appearance.
20	15	"	fair	light brown	"	"	50	3.0	Rough surface, but sound.
21	15	Hamilton	good	brown	clear	"	70 to 80	3.0	Good appearance. Well shaped.
22	18	"	very good	dark brown	"	"	40	2.0	Real good looking pipe.
23	18	"	good	brown	fairly clear	over med.	25	5.0	Fire crack in bell weakened pipe.
24	18	Ontario	fair	"	clear	hard	55	2.2	Rough surface, not good color but sound.
25	18	"	poor dull	light brown	"	over med.	20 to 30	4.7	Well shaped, but poor color and glaze.


ESTIMATED ROUGH WEIGHTS
C. I. YOKE 1200
C. I. WHEEL 135
C. I. BASE 2500
BRASS RING NUT 17
PHOS. BRZE SLEEVE NUT 90
MANGANESE BRZE SOCKET 65
M. STEEL SPINDLE 250
M. STEEL COLUMNS 480
F. S. NUTS KEYS ETC. 60
ONE NUT BRASS
MACHINE STEEL SPINDLE
SINGLE SQUARE THREAD
TWO PER INCH R.H.
6 R. HAND THRDS PER INCH
DRIVE FIT
ONE YOKE REQ'D CAST IRON
TWO KEYS
ONE WHEEL REQ'D CAST IRON
1/4" PIPE AND AIR COCK
TWO COLUMNS REQ'D MACHINE STEEL
30" MAX. PIPE DIAM.
6" MIN. PIPE DIAM.
ONE SLEEVE NUT PHOS. BRONZE
ONE SOCKET MANGANESE BRZE
1 1/4" DIAM. 1/4" PIPE CONNECTION GREASE CUP
1/2" AIR COCK AND PIPE TO BE REMOVED AND 1/4" PIPE PASSED THROUGH HOLE INTO SPECIAL TAPPING FOR SMALL PLATES
ONE BASE REQ'D CAST IRON
6 R.H. THRDS PER INCH
HEX NUTS 5 3/8" ACROSS FLATS TAPPED 3 1/2" 6 R.H. THRDS PER IN.
2" DRILL
1 3/4" DIAM. CORE
1 1/4" PIPE TAP
2" CENTRE RIB
3 1/2" BORE PRESS FIT
HYDRAULIC TESTING MACHINE
FOR
6" TO 30" VITRIFIED CLAY SEWER PIPE
CAPACITY 150# PER SQ. INCH INTERNAL PRESS.
PROVINCIAL BOARD OF HEALTH OF ONTARIO
SEPT 26-17


STEEL PLATES
ALL PLATES EXCEPT TWO SMALLEST TAPPED THUS
SPECIAL TAPPING FOR TWO SMALL PLATES ONLY
1/4" PIPE TAP FOR AIR PIPE
CLIPS 3/16" STEEL PLATE
INSIDE DISTANCE A
1/2" TAP BOLTS DO NOT TAP THROUGH
DIMENSION B
ONE REQ'D 10 9/16" DIAM.
SPECIAL
PURE RUBBER RINGS
WIDTH X
TWO REQ'D 7 3/4" DIAM.
RUBBER GASKETS
TWO OFF EACH
W.I. RING
ONE REQ'D 7 3/4" DIAM.
RETAINER RINGS
ONE OFF EACH
HYDRAULIC TESTING MACHINE DETAILS
FOR
6" TO 30" VITRIFIED CLAY SEWER PIPE
CAPACITY 150# PER SQ. IN. INTERNAL PRESS.
PROVINCIAL BOARD OF HEALTH
OF ONTARIO
SEPT 27-17

opinion of the operator, any pipe tested which burst at a pressure lower than 40 lbs. per square inch was either defective or seriously weakened by the end pressure of the bolts which were observed in some instances to open up fire cracks in the bell.

By referring to the table one can note that:—

(1) The glaze and colour have little to do with the strength of the pipe.

(2) The hard burned pipe are stronger than the soft burned.

(3) The absorption is lower in the hard burned pipe.

(4) Great strength and low absorption go together.

One observes here as well as in the external pressure tests, that thorough vitrification or low absorption and careful annealing are the factors which will insure long life for the product.

After completing the tests just described we are in a position to suggest some improvements on our method of testing.

When the sewer pipe is in the ground the edge of the bell of the pipe does not butt against any surface, and so it is not necessary to have its edges so even

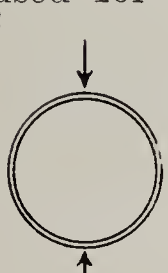
that when stood on end on a flat surface one gets contact at every point. Very few samples have perfectly even edges to the bell and sometimes the waving depressions in the edge may be deeper than the thickness of the rubber gasket used in testing. Any degree of tightness of the bolts will not press the gasket tight enough to make a leak-proof joint. It was in trying to keep the joints tight that we squeezed the samples and weakened them.

Now the spiggot end of a pipe is (required by specification) even and in a flat plane at right angles to its axis, as is also the inner seat of the bell, i.e., the spiggot end of one pipe with the bell end of another butted together would give perfect contact at all points.

An improved testing machine was designed, and is shown on plate No. 15 and 16. The use of such a machine, by testing laboratories, is recommended.

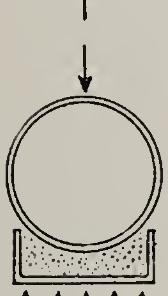
Resistance to External Pressure.

Considerable literature *re* the strength of sewer pipe in the United States of America has been published, but, as Ontario clays and the final products differ from those in the United States, the above mentioned figure could not well be used for Ontario pipe.

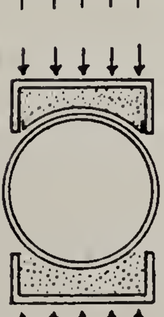


Several different crushing tests have been used at various times to determine the relative resistance to forces which tend to crush a pipe when laid on its side in a trench. These may be divided as follows:—

(*a*) Tests made by laying the pipe on its side and applying a load top and bottom, the crushing load being applied along a comparatively narrow line. This is spoken of in the literature on the subject as knife-edge or two-point bearing crushing tests.



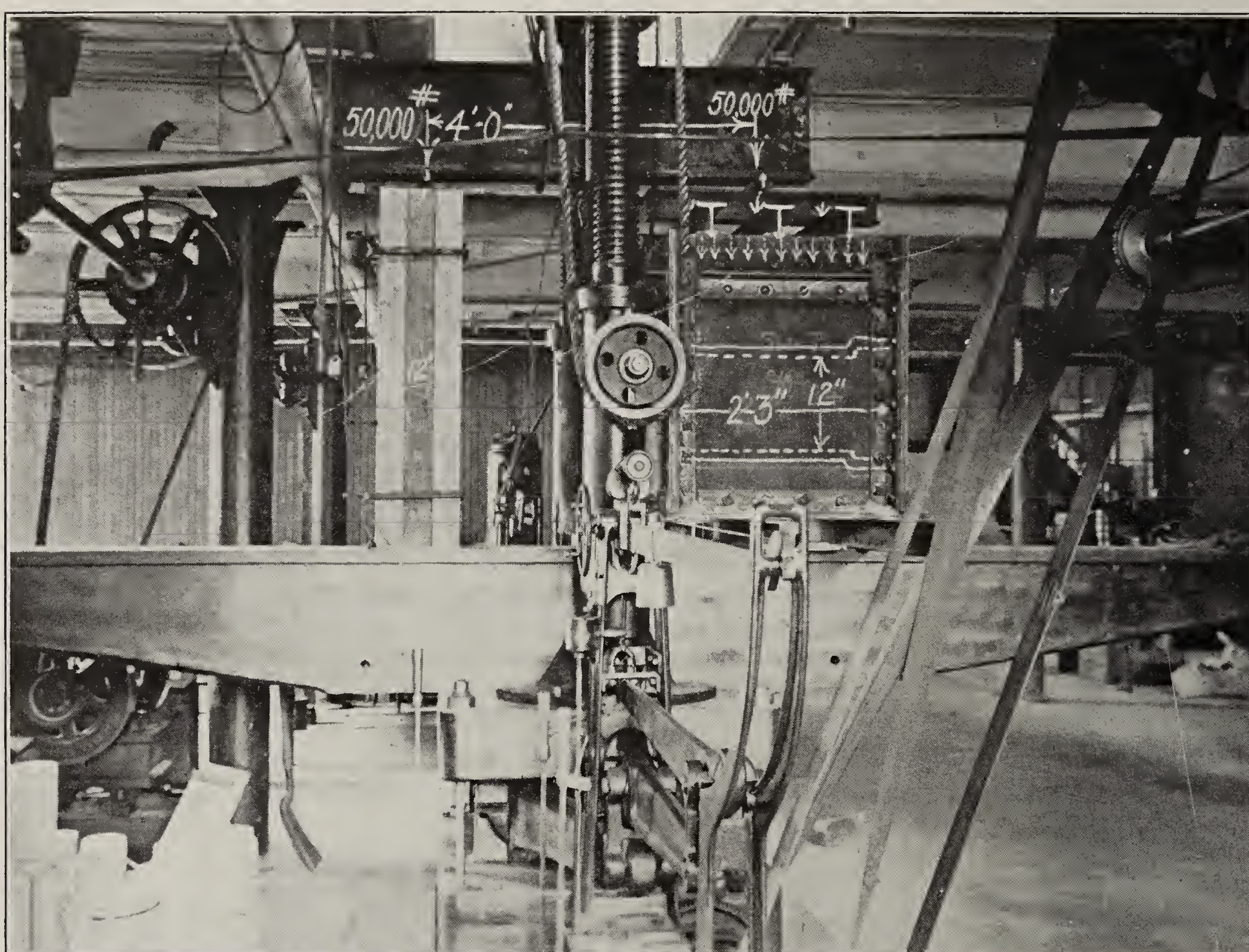
(*b*) Tests made by laying the pipe on its side on a sand bearing and applying a crushing load at the top, either knife-edge that is 1-inch steel bar or any surface up to 2½ inches.



(*c*) Tests made by laying the pipe on its side on a sand bearing, the crushing load being applied to the pipe through a saddle constructed to conform to the upper ⅓ segment.

All of these methods produce figures that permit of comparison of the same or different makes of pipe but unfortunately they do not appear to closely resemble the manner in which a crushing load is applied in actual service in the ground.

A sewer pipe laid in a trench receives more load at the top and bottom than it does at the side and yet there is no part of its circumference that does not receive some load. In an effort to have the load applied as in practice we designed, and had built what was practically a steel trench the length of one pipe and the width of an ordinary trench. The pipe to be tested was completely imbedded in sand, the load applied to the surface of the sand and distributed to the surface of the pipe. The ends of the pipe were close to the end plates of the box and the sand was prevented from flowing into the pipe by the use of thick felt gaskets. The pressure on the sand surface was applied by means of a reinforced 1-inch steel plate or ram sufficiently strong and stiff to exert a load of 150 lbs. per



Apparatus arranged for testing resistance of sewer pipe to external pressure. Pipe is laid in sand in the steel box with a cushion of sand on top to transfer the pressure. University of Toronto Testing Laboratories—Strength of materials.

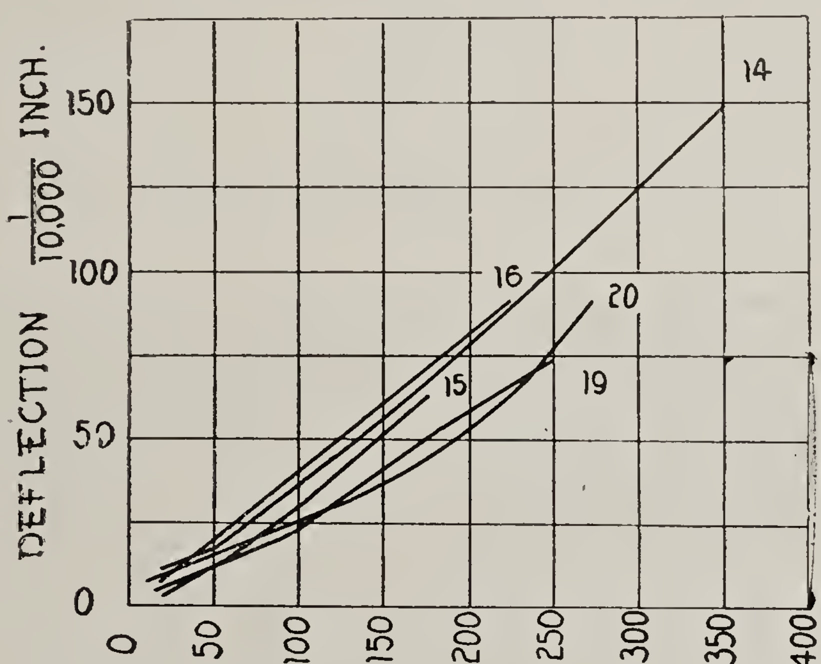
square inch. The capacity of the compression machine was 100 tons. The space between the box walls and the ram was one-half inch and the apparatus was of such a size that all pipe up to and including 15-inch diameter could be tested in it. Each end of the box had a 4-inch observation hole in it, photo No. 44.

Before making the test the pipe was carefully examined and measured. Sufficient sand was put in box so that when pipe was placed on it, the centre of the pipe would be opposite the observation hole of the end plate. The felt gasket was snugly fitted to the pipe ends. A little more sand was put in and tamped carefully and tightly so that the pipe would have an evenly distributed load on it. A few inches of sand were added followed by tamping till the box was full flush with the top. The ram or lid was carefully centred on top of the sand and

then by means of a series of I-beams and cast iron bars the load from the machine was evenly distributed to the surface of the sand which had an area of 650 square inches.

With everything in place an electric bulb was put in one end of the pipe and the observer stationed at the 4-inch opening at the other end. With the small sizes 4 inch, 6 inch and 8 inch, the load was added in increments of 5,000 lbs. The pipe and apparatus being examined after each addition, the load was increased till one could hear a sharp cracking sound. At this point the machine was stopped and the load read off. In each case just two cracks could be observed running longitudinally the entire length of the pipe exactly at the top and bottom of the pipe.

With the larger sizes 9 inch, 12 inch, and 15 inch we measured the deflection or change in diameter in vertical and horizontal planes, by means of a small instrument that could be read to the ten-thousandth part of an inch. While taking these readings the load was added in increments of 2,500 lbs. With some samples we took readings up to a point near the breaking point and then released the load, noting that the diameter returned to normal again with the load off.



As the pipe did not fly into pieces it was possible to make deflection readings right up to the point of fracture.

Having broken the pipe the ram was removed and the sand dug out till the top surface of the pipe appeared. The crack that was readily seen from the inside could scarcely be discerned from the outside.

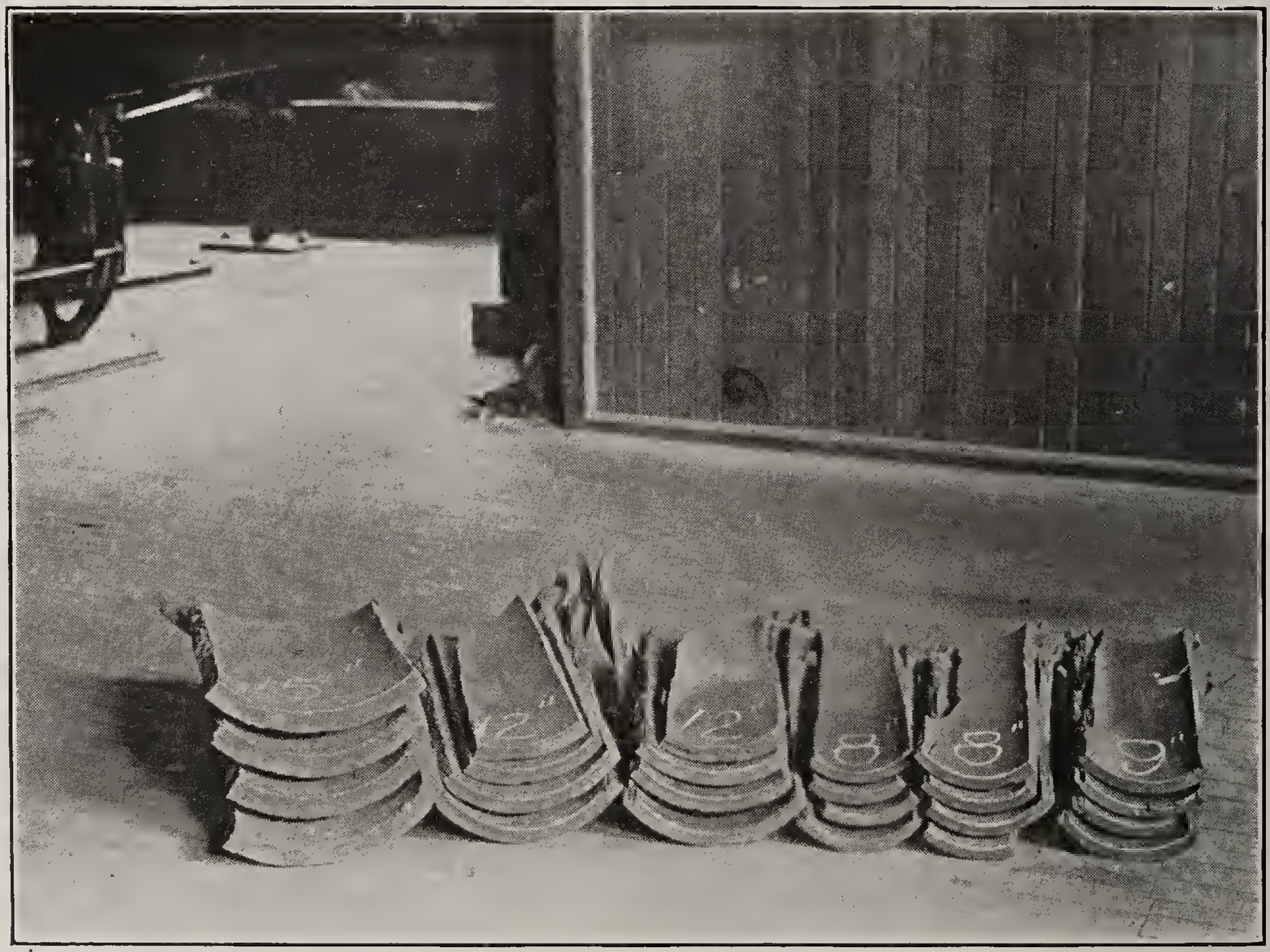
On cleaning out the sand till half the pipe was exposed, in nearly every case one could observe a crack running longitudinally along both sides of the pipe at points just a little above a horizontal plane through its centre. These cracks were seldom noticeable from the inside. This led us to conclude that the pipe was bending outward at these points. The deflection needle showed us that such was the case. The diameter in a vertical plane through the centre of the pipe decreased under a load and the diameter through a horizontal plane through the same point increased as the load in the pipe increased.

TABLE No. 13.

Showing change in diameter in a vertical plane through the centre of the pipe when subjected to an increasing load. Measurements in $\frac{1}{10000}$ inch.

Lbs. pressure on ram.	Deflections in $\frac{1}{10000}$ inch.						
	No 14.	15	16	17	18	19	20
2,500 lbs	12	7	10	17	10	4	11
5,000 "	17	11	20	30	16	12	15
7,500 "	26	20	30	45	25	17	21
10,000 "	37	30	41	62	34	23	25
12,500 "	46	41	51	80	45	32	31
15,000 "	57	52	61	97	55	42	37
17,500 "	67	62	71	110	66	52	42
20,000 "	78	352	80	131	77	59	52
22,500 "	89	....	91	531	....	68	62
25,000 "	100	....	109	....	....	74	77
27,500 "	112	....	219	....	....	200	93
30,000 "	125	....	....	....	....	....	112
32,500 "	136	....	....	....	....	....	127
35,000 "	147	....	....	....	....	....	197
37,500 "	181	....	....	....	....	....	....
Size of pipe	12″	12″	12″	15″	15″	15″	15″

[The most flexible of the above samples showed a deflection of $\frac{147}{10000}$″ before it cracked, or a twelve-inch pipe bent in only 1½ one-hundredths of an inch before breaking.]

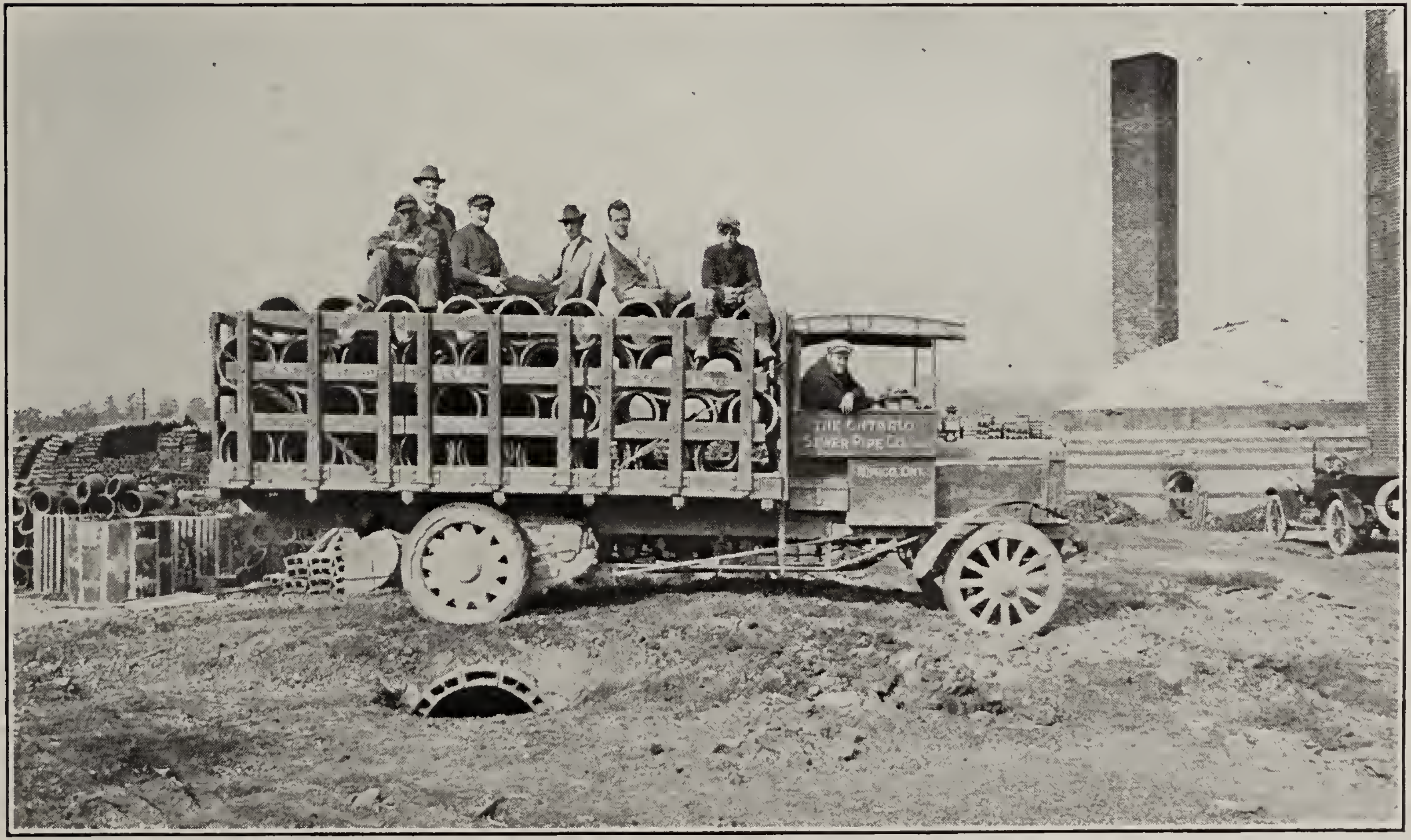


The result of external pressure on sewer pipe is that they break longitudinally in almost equal segments.

The specimen was removed from the box and if it did not fall into pieces it could readily be pulled apart by hand, breaking up into four almost equal segments.

Table No. 14 contains the record of the testing observations.

Sewer pipe used on the Good Road construction, Toronto-to-Hamilton Highway.



Testing segment block with a 7-ton truck, Mimico.

TABLE

No.	Size	Mfr.	Thickness of shell.	Inside Spiggot.	Outside Spiggot.	Inside Bell.	Outside Bell.	Depth of Bell.	Length over all.	Color.	Ring.	How burned.	Glaze.
			inch	inch	inch	inch	inch	inch	inch				
1	4″	Ontario ..	$\frac{9}{16}$	$3\frac{3}{4}$	$5\frac{1}{4}$	$5\frac{3}{4}$	$6\frac{3}{4}$	$1\frac{3}{4}$	$25\frac{1}{2}$	dark brown	very clear	hard	fair
2	4″	"	$\frac{9}{16}$	$3\frac{3}{4}$	$5\frac{1}{4}$	$5\frac{3}{4}$	$6\frac{3}{4}$	$1\frac{3}{4}$	$25\frac{1}{2}$	"	"	"	"
3	4″	Hamilton .	$\frac{5}{8}$	$3\frac{7}{8}$	$5\frac{1}{8}$	$5\frac{3}{4}$	$6\frac{5}{8}$	$1\frac{3}{4}$	$25\frac{3}{4}$	dk br.	very clear	hard	good
4	4″	"	$\frac{5}{8}$	$3\frac{7}{8}$	$5\frac{1}{8}$	$5\frac{3}{4}$	$6\frac{5}{8}$	$1\frac{3}{4}$	$25\frac{3}{4}$	"	"	"	"
5	6″	Ontario...	$\frac{5}{8}$	6	$7\frac{1}{4}$	$8\frac{1}{4}$	$9\frac{1}{2}$	2	25	light brown	clear	"	none
6	6″	"	$\frac{5}{8}$	6	$7\frac{1}{2}$	$8\frac{1}{4}$	$9\frac{3}{4}$	2	$25\frac{3}{4}$	"	"	"	less thanfr
7	6″	Hamilton .	$\frac{23}{32}$	$5\frac{3}{4}$	$7\frac{1}{8}$	8	9	2	$25\frac{1}{2}$	dk. br.	"	very hard	fair
8	6″	"	$\frac{11}{16}$	$5\frac{3}{4}$	$7\frac{1}{8}$	$8\frac{1}{2}$	$9\frac{1}{4}$	2	26	brown	"	hard	"
9	8″	Ontario ..	$\frac{3}{4}$	8	$9\frac{1}{2}$	$10\frac{1}{2}$	$11\frac{1}{2}$	2	26	dk. br.	very clear	"	good
10	8″	"	$\frac{13}{16}$	$8\frac{1}{16}$	$9\frac{3}{4}$	$10\frac{5}{8}$	$11\frac{3}{4}$	$2\frac{1}{4}$	26	lt. br.	fair	med. or soft	hardly fair
11	9″	Hamilton .	$\frac{13}{16}$	9	$10\frac{9}{16}$	$11\frac{3}{8}$	$12\frac{1}{2}$	$2\frac{1}{8}$	26	dk. br.	good	med hard	good
12	9″	"	$\frac{13}{16}$	$9\frac{1}{3}$	$10\frac{5}{8}$	$11\frac{3}{4}$	$12\frac{3}{4}$	$2\frac{1}{8}$	$26\frac{1}{4}$	"	fair	soft	fair
13	12″	Ontario...	1	12	$13\frac{3}{4}$	15	$16\frac{1}{2}$	$2\frac{1}{4}$	$26\frac{1}{4}$	grey'h br.	"	hard	none
14	12″	"	1	12	14	$15\frac{1}{4}$	$16\frac{3}{4}$	$1\frac{1}{4}$	$26\frac{1}{4}$	lt. br.	ex.	"	fair
15	12″	Hamilton .	$\frac{15}{16}$	$11\frac{7}{8}$	$12\frac{3}{4}$	$14\frac{5}{8}$	$16\frac{1}{8}$	$2\frac{1}{2}$	$26\frac{1}{4}$	dk. br.	good	med. hard	good
16	12″	"	1	12	14	$14\frac{7}{8}$	$16\frac{1}{8}$	$2\frac{5}{8}$	$26\frac{1}{4}$	"	fair	"	"
17	15″	Ontario...	$1\frac{3}{8}$	$15\frac{1}{4}$	18	19	21	$3\frac{1}{4}$	$27\frac{1}{8}$	lt. br.	good	hard	none
18	15″	"	$1\frac{3}{8}$	$15\frac{1}{4}$	18	19	21	$3\frac{1}{4}$	$27\frac{1}{8}$	"	"	"	"
19	15″	Hamilton .	$1\frac{5}{16}$	$14\frac{3}{4}$	$17\frac{1}{4}$	19	$21\frac{1}{4}$	3	$26\frac{5}{8}$	dk. br.	ex.	very hard	good
20	15″	"	$1\frac{5}{16}$	$14\frac{7}{8}$	$17\frac{5}{8}$	$19\frac{1}{3}$	$21\frac{1}{4}$	3	$26\frac{5}{8}$	br.	good	med. hard	"

No. 14.

Flaws.	Sand under Spiggot.	Under bell.	Sides of Spiggot.	Sides of bell.	Over Spiggot.	Over bell.	Load on ram.	% Absorption.	Lbs. per sq. inch.	Load per running ft. of pipe.	Deflection of diam. at breaking pt.	Remarks.
	inch.	inch	inch.	inch	inch	inch.	lbs.	%	lbs.	lbs.		
none	12	11	10	9	17½	16½	60,000	3.5	92	5,216	......	Broke longitudinallyin almost equal segments
"	12	11	10	9	17½	16½	75,000	......	115	6,380	....	Pipe did not crack
"	12	11	10	9	17½	16½	80,000	2.3	123	6,740	....	Sample did not crack.
"	12	11	10	9	17½	16½	75,000	......	115	6,330	....	
"	10½	9¼	9	7¾	16½	15¼	50,000	1.3	77	6,003	....	
"	10½	9	9	7¾	16½	15¼	47,500	5.0	73	5,899	....	
"	10½	9¼	9	7	16½	15¼	59,000	1.7	91	6,956	....	
"	10½	9¼	9	7	16½	15¼	50,500	3.2	78	5,953	....	
"	9¾	8¾	7¾	6¾	15¼	14¼	50,000	1.0	77	7,866	....	
"	9¾	8¾	7⅜	6¾	15¼	14¼	37,500	4.8	57	6,120	....	
"	9¼	8¼	7¼	6¼	14¾	13¾	33,500	6.5	51	5,800	....	
"	9¼	8¼	7¼	6¼	14¾	13¾	26,000	4.1	40	4,450	....	
"	7⅜	6¼	5½	4½	13½	12¼	50,000	2.2	77	11,400	....	This was a particularly tough specimen, tho' not a fine looking pipe.
"	7	5¾	5½	4½	13½	12¼	37,500	1.0	57	8,700	$\frac{147}{10000}$"	
"	7¾	6¼	6	4½	13½	12¼	20,000	2.0	30	4,550	$\frac{70}{10000}$	
"	7½	6½	5½	4½	13½	12¼	27,500	6.1	42	6,400	$\frac{109}{10000}$	
"	5½	4½	3½	2½	11	8¾	25,300	4.1	39	7,460	$\frac{131}{10000}$	
"	5½	4½	3½	2½	11	10	27,500	3.1	42	8,200	....	
fire c'k in bell	5¾	4½	3¾	2½	11¾	10	25,000	1.0	38	7,140	$\frac{80}{10000}$	This sample was very brittle, very hard burned, but not tough.
"	5¾	4½	3¾	2½	11¾	10	30,000	1.5	46	8,700	$\frac{90}{10000}$	

The results show that the smaller pipes are capable of taking greater trench loads than the larger pipes. Certainly a much greater load per square inch is necessary to crack them. The column headed load per running foot does not show as great variation for different sizes as some of the other columns, because although the load per square inch in the sand may be greater for the smaller

TABLE NO. 15.

Trench Pressures for Sewer Pipe, in Pounds per Linear Foot.

Height of Fill above Top of Pipe.	Breadth of Ditch a Little Below Top of Pipe.									
	1 ft.		2 ft.		3 ft.		4 ft.		5 ft.	
	Ditch Filling Material.		Ditch Filling Material.		Ditch Filling Material.		Ditch Filling Material.		Ditch Filling Material.	
	Sand.	Clay.	Sand.	Clay.	Sand.	Clay.	Sand.	Clay.	Sand.	Clay.
ft.										
2.......	220	235	510	530	805	825	1,105	1,125	1,405	1,425
4.......	335	375	880	935	1,455	1,520	2,045	2,115	2,635	2,710
6.......	390	455	1,140	1,250	1,975	2,105	2,840	2,980	3,715	3,865
8.......	420	505	1,335	1,490	2,395	2,595	3,515	3,745	4,660	4,910
10.......	440	535	1,470	1,680	2,730	3,010	4,085	4,410	5,490	5,850
12.......	445	550	1,565	1,825	3,000	3,355	4,570	5,000	6,220	6,695
14.......	450	560	1,635	1,935	3,215	3,650	4,980	5,515	6,855	7,460
16.......	455	565	1,690	2,020	3,385	3,895	5,330	5,970	7,410	8,145
18.......	455	570	1,725	2,085	3,525	4,100	5,625	6,360	7,900	8,770
20.......	455	575	1,750	2,135	3,640	4,275	5,875	6,715	8,330	9,325
22.......	455	575	1,770	2,175	3,725	4,420	6,090	7,020	8,705	9,830
24.......	455	575	1,785	2,205	3,800	4,545	6,270	7,290	9,035	10,285
26.......	455	575	1,795	2,230	3,855	4,645	6,420	7,530	9,325	10,690
28.......	455	575	1,800	2,245	3,905	4,735	6,550	7,735	9,575	11,060
30.......	455	575	1,805	2,260	3,940	4,805	6,660	7,920	9,795	11,395
Very great..	455	575	1,820	2,310	4,090	5,190	7,270	9,230	11,365	14,425

[1]Prepared from the Standard Specifications for Drain Tile (Serial Designation: C 4-16), 1916 Book of A.S.T.M. Standards, p. 452. "The table gives safe trench pressures for sewer pipe, for sand and thoroughly wet clay ditch filling material. It has been prepared for a safety factor of 1½ which has been found necessary to prevent cracking from the loads of ditch filling."

pipe, the larger pipe have more surface per running foot; or 91 lbs. per square inch on a six inch pipe gives less load per running foot than 42 lbs. per square inch for a 12-inch pipe.

The trench load per foot run is probably not in this ratio. Observe table No. 15 recommended for use in sewer design.

TABLE No. 16.

Stresses if uniform load is assumed.

Size.	4 inch.	6 inch.	8 and 9 inch.	12 inch.	15 inch.
	lbs.	lbs.	lbs.	lbs.	lbs.
Lbs. per square inch..................	111	80	56	51	41
Average load per running foot	6,166	6,152	6,060	7,760	7,870
Lbs. per sq. in. × 12 × dia. (inches)...	....	....	....	....	....

These figures on Canadian pipe are much higher than are given for United States pipe. This may be because our pipe is stronger and tougher or because of our method of estimating the load.

According to the table No. 16, all the sizes tested of the Canadian pipe were many times the strength required to carry the load of the deepest trench. A safety factor of $1\frac{1}{2}$ is usual for this class of material.

The local sewer pipe of standard size appear to be strong enough to resist any load that might be applied in practice.

The strength of sewer pipe depends on the most important step in its manufacture, vitrification.

The most thoroughly vitrified and annealed pipe will best resist internal pressure, external pressure, mechanical erosion and chemical action.

Office and dray, Hamilton-Toronto Sewer Pipe Co., Ltd.

4.—SPECIFICATION FOR VITRIFIED CLAY SEWER PIPE.

All standard sewer pipe and specials shall, unless otherwise specified, be of the best quality of vitrified clay salt glazed sewer pipe, of the bowl and spiggot pattern, and shall be true to form and size.

Quality

Clay sewer pipe shall be of the following sizes and dimensions:—

TABLE No. 17.

Proposed Standard Sizes and Dimensions of Clay Sewer Pipe.

Diameter.	Thickness.	Depth of Socket.	Annular Space.
Inch.	Inch.	Inch.	Inch.
6	¾	2½	½
8	¾	2¾	½
9	⅞	2¾	½
10	⅞	2¾	½
12	1	3	½
15	1¼	3	¾
18	1½	3¼	¾
20	1⅔	3½	¾
24	2	4	1
30	2½	4½	1

TABLE No. 17 A.

Alternative Sizes and Dimensions of Clay Sewer Pipe.

D Internal Circular Diameter.	L Laying Length.	H Diameter at Inside of Hub.	S Depth of Hub.	B Taper of Hub.	T Minimum Thickness of Shell.
in.	Feet.	in.	in.		in.
6	2	8¼	2	1:20	⅝
8	2, 2½, 3	10¾	2½	1:20	¾
9	2, 2½, 3	11⅞	2½	1:20	⅞
10	2, 2½, 3	13	2½	1:20	⅞
12	2, 2½, 3	15¼	3	1:20	1
15	2, 2½, 3	18¾	2	1:20	1¼
18	2, 2½, 3	22¼	3	1:20	1½
20	2, 2½, 3	25¼	3½	1:20	1¾
21	2, 2½, 3	26	3½	1:20	1¾
24	2, 2½, 3	29½	3½	1:20	2
27	3	33¼	4	1:20	2¼
30	3	37	4½	1:20	2½
33	3	40¼	5	1:20	2⅝
36	3	44	5	1:20	2¾
39	3	47¼	5	1:20	2⅞
42	3	51	5	1:20	3

Note.—When pipes are furnished having an increase in thickness over the dimensions given in column T, then the diameter of the hub H shall be increased by an amount equal to twice the increase of thickness of shell.

Curved pipes, bends, slants, and branches are to be equal in all essential respects to the straight pipes of the same diameter.

All pipes and specials shall be well vitrified free from blisters, laminations, lime spots and free from cracks and checks extending into the body of the tile in such a manner as to appreciably decrease the strength.

All pipes and specials when struck with a light hammer, shall emit a clear high pitched ring. On fracture the absorption shall not exceed five per cent.

Pipe designated straight shall not vary from a straight line more than one-eighth inch per feet of length.

Curves shall be at angles of 45, 22½, 11¼ degrees, etc., as required. They shall substantially conform to the curvature specified.

The ends of pipe and specials shall be square with their longitudinal axis or tangent.

Absorption Test

The specimens shall be sound pieces, with all edges broken, from pipes broken in the crushing or other tests. They shall be from 12 to 20 square inches in area, and shall be as nearly square as can be readily prepared. They shall be free from observable cracks, fissures, laminations or shattered edges.

Preparatory to the absorption test, the specimen shall be first weighed and then dried in a drier or oven at a temperature of not less than 110°C. (230°F.) for not less than three hours. After removal from the drier, the specimen shall be allowed to cool to a temperature of 20 to 25° C. (68 to 77° F.) and then reweighed.

If the specimen was comparatively dry when taken, and the second weight closely agrees with the first, it shall be considered dry. If the specimen was known to be wet when taken it shall be placed in the drier for a further drying treatment of two hours, and reweighed. If the third weight checks the second the specimen shall be considered dry. In case of any doubt, the specimen shall be redried for two-hour periods, until check weights are obtained.

The balance used shall be sensitive to 0.5 g. when loaded with 1 kg., and weighings shall be read to the nearest gram. When other than metric weights are used, the same degree of accuracy shall be obtained.

The specimen after final drying, cooling and weighing shall be placed with other similar specimens in a suitable wire receptacle, packed tightly enough to prevent jostling, covered with distilled water or rain water, raised to the boiling point and boiled for five hours, and then cooled in water to a final temperature of 10 to 15° C. (50 to 59° F.).

The specimen shall be allowed to drain for one minute, the superficial moisture removed by towel or blotting paper, and then placed upon the balance.

The test result shall be calculated as percentage of the initial dry weight.

Inspection

All sewer pipes shall be subject to inspection at the factory, trench or other point of delivery by a competent inspector employed by the purchaser or consumer. The purposes of the inspection shall be to cull and reject pipes which, independent of the physical tests herein specified, fail to comply with the requirements of these specifications.

Sewer pipes shall be subject to rejection on account of the following:

(*a*) Fracture or cracks passing through the shell or hub, except that a single crack at either end of pipe not exceeding two inches in length or a single fracture in the hub not exceeding three inches in width or two inches in length will not be deemed cause for rejections unless these defects exist in more than five per cent. of the entire shipment or delivery.

(*b*) Blisters where the glazing is broken or which exceed three inches in any diameter, or which project more than ⅛ inch above the surface.

(*c*) Laminations which indicate large voids in the pipe material.

(*d*) Fire cracks or hair cracks sufficient to adversely affect the strength, durability or serviceability of the pipe.

(*e*) Failure to give a clear ringing sound when placed on end and dry tapped with a light hammer.

(*f*) The presence of any considerable number of lime spots.

(*g*) The presence of any holes due to presence of vegetable matter in the unburnt clay.

All rejected sewer pipes shall be plainly marked by the inspector and shall be replaced by the manufacturer or seller with pipes which meet the requirements of these specifications without additional cost to the purchaser or consumer.

DEPARTMENT OF THE PROVINCIAL SECRETARY

Suggested Standards for Sewer Construction

By F. A. DALLYN, C.E. (Tor.)
Provincial Sanitary Engineer

CONTENTS

THE PROVINCIAL BOARD OF HEALTH OF ONTARIO

1. Standard Proposal for Bids or Estimates, Schedule of Measurement, Schedule of Municipal Prices for Extra Work, 1917.

DESCRIPTION OF WORK.

Together with the work incidental thereto.

2. Sealed bids or estimates for the above work will be received at the office of the Clerk of the .... of .... until.... o'clock ..M. .... on .... day of .... 191 .

3. The time allowed for constructing and completing the sewer and appurtenances will be .... CONSECUTIVE WORKING DAYS.

4. No bid will be considered unless the bidder shall furnish evidence satisfactory to the .... that he has the necessary facilities, ability and pecuniary resources to fulfill the conditions of the contract and specifications.

5. The amount of security to be deposited with the Bid or Estimate is ($) .... Dollars (equal to 10 per cent. of the Bond).

6. The person or persons making a bid or estimate, shall furnish the same in a sealed envelope, endorsed with the title of the work given above, for which the estimate is made, with his or their name or names and the date of presentation to the clerk of .... of .... at ...., on or before the date and hour above named, at which time and place the estimates received will be publicly opened by clerk of the .... of .... and read, and the award of the contract made according to law as soon thereafter as practicable. No bid shall be withdrawn pending the award.

7. Each bid or estimate shall contain the name and place of residence of the person making the same; the names of all persons interested with him therein, and if no other person be so interested, it shall distinctly state that fact; also that it is made without any connection with any other person making an estimate for the same purpose, and is in all respects fair and without collusion or fraud, and that no member of the .... of the .... of .... or other officer of the .... of .... is, shall be or become interested, directly or indirectly, as contracting party, partner, stockholder, surety or otherwise, in or in the performance of the contract, work or business to which it relates, or in any portion of the profits thereof. The bid or estimate must be verified by the oath in writing of the party making the estimate that the several matters stated therein are in all respects true.

8. Each bid or estimate shall be accompanied by the consent, in writing, of two householders or freeholders in the Province of Ontario, with their respective places of business or residence, or of an authorized and approved (incorporated) surety company, to the effect that if the contract be awarded to the person making the estimate they will, upon it being awarded, become bound as his sureties for its faithful performance; and that if he shall omit or refuse to execute the same, they will pay to the .... of .... any difference between the sum to which he would be entitled upon its completion and that which the corporation may be obliged to pay to the person to whom the contract may be awarded at any subsequent letting; the amount in each case to be calculated upon the estimated amount of the work by which the bids are tested. The consent above mentioned shall be accompanied by the oath or affirmation in writing of each of the persons signing the same, that he is a householder or freeholder in the Province of Ontario

and is worth the amount of the security required for the completion of the contract as stated in the proposal, over and above all his debts of every nature, and over and above his liabilities as bail, surety and otherwise; that he has offered himself as a surety in good faith, and with an intention to execute the bond required by law if the contract shall be awarded to the person or persons for whom he consents to become surety. The adequacy and sufficiency of the security offered to be approved by the .... of the .... of .... after the award is made and prior to the signing of the contract.

9. The bond shall be in the form approved by the .... of .... and attached hereto. The expense of preparing the contract and bond is to be paid by the corporation, but the expense of getting the same executed, if any, is to be borne by the contractor.

The amount of the bond required for this contract is fifty (50) per cent. of the Contractor's Bid.

10. No estimate will be received or considered unless accompanied either by a certified cheque upon one of the chartered Canadian Banks located in the .... of ...., drawn to the order of the .... or money or corporate stock or certificate of indebtedness of any nature issued by the .... of .... which the .... shall approve as of equal value with the security required, to an amount of ten per centum of the amount of the bond required, as provided for the faithful performance of the contract. Such cheque, money or other form of security must not be enclosed in the sealed envelope containing the estimate, but must be handed to the officer or clerk of the .... of .... who has charge of the estimate box, and no estimate can be deposited in said box until such cheque, money or other form of security has been examined by said officer or clerk and found to be correct. All such deposits, except those of the lowest three bidders, will be returned to the persons making the same within ten days after the opening of the bids; within three days after the decision as to whom the contract is to be awarded the deposits will be returned to the remaining persons making the same, except the deposit made by the bidder whose bid has been accepted. If the successful bidder shall refuse or neglect within five days after notice that the contract has been awarded to him, and after that the adequacy and sufficiency of the security offered has been approved by the .... of the .... of .... to execute the same, the amount of the deposit made by him shall be forfeited to and retained by the corporation of the .... of .... but if he shall execute the contract within the time aforesaid, the amount of this deposit will be returned to him within three days after the execution of the said contract.

11. Bulk Sum Bids for the whole work or individual contract only will be accepted, and it is further required that the contractor shall

execute whatever additional or extra work may be required at the municipal rates specified in the Description of Work under Schedule of Measurement and in strict conformity in all respects with the requirements of the contract and specification for the proposed work.

12. Contractors desiring to submit bids for both the work as a whole or for any individual project must do so on separate bids. Contractors will not be asked to undertake individual contracts who have only bid on the same when considering the work as a whole.

SCHEDULE OF MEASUREMENT

13. Measurements are taken nett, any general or local custom to the contrary notwithstanding; unless where specially mentioned otherwise.

The work not herein provided for and ordered by the Engineer will be measured up, on completion and the actual amount of extra work executed paid for at the prices marked "municipal rates" stated opposite each description of work in the Schedule of Measurement.

Schedule municipal prices shall include the cost of all labour, material, carriage, plant and machinery of every description for carrying on and completing the contract in the most approved and tradesmanlike manner to the satisfaction of the Engineer.

It is especially requested that Contractors make themselves thoroughly acquainted with the nature of the work previous to submitting a Bid or Estimate.

DESCRIPTION OF WORK

Quantities	Description of Work	Municipal Rate	Contractor's Estimate	Amount
Yds. Ft. Ins.	**PAVEMENT.**			
	Sup'l ....pavement to lift, lay aside and reinstate as bottoming, include for making up surface of road with new .... to a depth of .... on completion of work, rolling and consolidating to the satisfaction of the Engineer			
	Sup'l .... pavement Do..... Lin. ....curb and gutter Do. Lin. .... curb replaced Do. Sup'l concrete sidewalks replaced .... Sup'l flagstone sidewalks replaced .... Sup'l brick Sidewalk			
	Sup'l ....pavement			
	Lin. ....curb and gutter			
	Lin. ....curb and gutter			
	Sup'l concrete sidewalk			
	Sup'l .... sidewalk			
	Sup'l .... sidewalk			
	EXCAVATION.			
	Cube excavations in track of sewer for .... pipe average depth .... greatest depth .... planking and walings and struts of sufficient strength, rate to include re-filling track in .... layers, watering and beating and thoroughly consolidating the refilled material and removal of surplus excavated material to a deposit found by contractor or at the following sites			
	Cu. yd. trench not more than 11 ft. deep. Cu. yd. trench 11 to 15 ft. deep. Cu. yd. trench 15 to 25 ft. deep. Cu. yd. trench each 5 ft. below 25 ft. deep. Cu. yd. tunnel drifts.			

DESCRIPTION OF WORK.—Continued.

Quantities	Description of Work	Municipal Rate	Contractor's Estimate	Amount
Yds. Ft. Ins.				
	Cube. Do. Do. for .... pipe average depth .... greatest depth			
	Cube. Tunnel for			
	Cube. Do. Extra over ordinary excavations in manhole shafts...Do., Do. Cube. Excavation in rock. Work ordered by Engineer other than that asked for in estimate................			
	MASONRY.			
	Cube. Concrete " Class ...... " forming ....Municipal rate inclusive reinforced cement			
	Cube. Concrete " Class ...... " laid .... Municipal rate includes reinforcement			
	Cube. Concrete " Class B " in foundations			
	Cube. Concrete " Class C " in foundations			
	Cube. Concrete in " Class D " in foundations and backing			
	Sup'l. Concrete " Class E " .... thick			
	Allow for connecting to existing...... ....vitrified brickwork .... not specified in place			
	Lin........... Composition brickwork in manholes built and neatly pointed on inside face with cement mortar, price to include plumbings, cuttings and waste.			
	Cube. Sewer brickwork			

DESCRIPTION OF WORK.—Continued.

Quantities	Description of Work	Municipal Rate	Contractor's Estimate	Amount
Yds. Ft. Ins.	LUMBER.			
	.... B.M. ....in foundations .... M.B.M.			
	.... B.M. .... sheeting, braces, shores, stringers, waling strips, left in place by order .... M.B.M			
	.... B.M. .... sheet piling .... M.B.M			
	Lin.....Circular timber—cedar, tamarac and other timber 8 inches diameter at small end ....Lin. Ft			
	Lin. Piles driven only according to instructions of Engineer .... Lin. Ft			
	PIPE AND PIPE LAYING.			
	Lin. .... diameter standard salt-glazed bowl and spigot sewer pipe to provide, lay and joint with .... and Portland cement mortar.			
	.......Pipe laid and jointed in trench .... per ft.			
	.......Pipe laid and jointed in trench .... per ft.			
	.......Pipe laid and jointed in trench .... per ft			
	.......Pipe laid and jointed in trench .... per ft			
	CONNECTIONS.			
	..............inch slants built in new brick sewers ....each....			
	..............inch slants built in.... .... sewers .... each....			
	.... Pipe (2 ft. length) built in brickwork or concrete ...... each....			
	.... Pipe (2 ft. length) Do. .... each....			
	.... Pipe (2 ft. length) Do. .... each....			

DESCRIPTION OF WORK.—Continued.

Quantities	Description of Work	Municipal Rate	Contractor's Estimate	Amount
Yds. Ft. Ins.				
	...........Junctions laid and jointed in trench .... each....			
	...........Junctions laid and jointed in trench .... each....			
	...........Junctions laid and jointed in trench .... each....			
	BENDS.			
	........Bends inserted at............			
	........Bends inserted at............			
	........Bends inserted at............			
	........Bends inserted at............			
	UNDERDRAINS.			
	Lin. .... tile underdrains as ordered, including excavations below sub-grade, laying and ballasting .... Lin. ft.			
	Lin. .... vitrified pipe underdrains Do. ....Lin. ft.			
	MANHOLES.			
	Sup'l. Portland cement concrete .... thick in bottoms of manholes hollowed and shaped as shown, and smoothed on upper surface with cement mortar (..........).			
	Manhole steps formed of 1 inch diameter galvanized malleable iron, each .... long with bent and palmed ends, built into brickwork			
	Cast iron manhole covers No. .... coated with Dr. Angus Smith's patent solution, rate to include bedding and setting in cement mortar.			
	Cube. Cement concrete ....thick round cast iron manhole heads			
	Lin. Manhole ladders galvanized			
	CATCH BASINS.			
	Concrete and brick masonry elsewhere provided for			

DESCRIPTION OF WORK.—Continued.

Quantities	Description of Work	Municipal Rate	Contractor's Estimate	Amount
Yds. Ft. Ins.				
	...........Gulley traps and tops supplied by .... connection to sewer, distance not to exceed .... feet except when ordered by Engineer as extra work...			
	FLUSH TANKS.			
	Concrete and brick masonry elsewhere provided for			
	............Syphons to be supplied by contractor .... connection to sewer			
	GENERAL ALLOWANCES.			
	Allow for removal of surplus material or rubbish of whatever kind other than that already specified to a deposit found by Contractor			
	Allow for furnishing and fitting up all necessary troughs or other appliances, including pumps which may be required for conveying water over, or past the works and keeping the trench dry during the construction of the sewer			
	Allow for making good all injuries to persons or property which may result through the execution of the works; and the settling of all claims in respect thereof			
	Allow for carefully supporting all gas and water pipes in line of work, and making good any damage which may result to same			
	Allow for lighting, watching and barricading the works to the satisfaction of the authorities			
	Allow suitable office for Clerk of Works, with stove, providing fuel and daily cleaning			
	Allow for providing all temporary roadways, footways, bridges, etc., for the use and convenience of the public.			
	Allow for all necessary scaffolding ...			
	Allow for maintaining the work for .... calendar months after completion			
	Allow for engineering and inspection.			
	Allow for work incidental to contract not elsewhere provided for			
	Allow for Bond issue depreciation ...			
	Total amount of Estimate			

MUNICIPAL RATES FOR ALLOWANCES.

	Dollars	Cents
Price per ...... for Mason		
Do. Do. Causeway layers..		
Do. Do. Bricklayer		
Do. Do. Labourers		
Do. Do. Watchman		
Do. Do. Team and Wagon, with man.......		

14. The estimated quantities are believed to be accurate for the material listed only and are given for the convenience of the contractor; they are not guaranteed to completely specify the work comprised in the contract and are not to be considered as limiting the contract to the before mentioned quantities. Such as can, should be checked and verified by the bidders after a careful examination of the plans, specifications and the location or site of the work.

15. For the convenience of contractors blue prints will be issued. These blue prints are to be returned under separate cover with the contractor's bid.

16. Bidders will be required to complete the entire work to the satisfaction of the Engineer of the .... of .... and in substantial accordance with the specifications hereunto annexed and the plan therein referred to. No extra compensation beyond the amount payable for the several classes of extra work ordered by the Engineer in charge of the work, in writing, which shall be actually performed at prices therefor specified in the contract, shall be due or payable for the entire work.

17. The contractor's estimates are to be included and to cover the furnishing of all material and the performance of all the labour requisite or proper for the purpose, and the building and completing of all the above mentioned work, of the materials and in the manner set forth, described and shown in the specifications and on the plan of the work.

18. Bidders are particularly requested to examine the plan, specification and location of the work before bidding. Bidders are informed that no deviations from the specifications will be allowed.

19. Bidders are especially notified that the ....
....
reserves the right to determine the times and places for commencing and prosecuting the work, and that the principal reserves the right to require that the work shall be done during daylight or working hours, notwithstanding unfavourable weather or other conditions. Postponement or delay on the whole, or any part thereof, occasioned by the precedence of other contracts, which may be either let or executed before or after the execution of the contract for this work, can constitute no claim for damages, nor for a reduction of the damages fixed for delay in completing the work beyond the time bid.

20. The price should be written in the bid and also stated in figures, and all estimates may be considered as informal which do not contain bids for all items for which prices are herein called. Permission will not be given for the withdrawal of any bid or estimate, and the right is expressly reserved by the .... of the .... of .... to reject all bids should they deem to the corporation's interest to do so. No bid will be accepted from, or contract awarded to, any person who is in arrears to the .... of .... upon debt or contract, or who is a defaulter, as surety or otherwise, upon any obligation to the .... of ....

21. Where test pits have been dug along the line of the work the location of the same with the character of the material encountered therein is shown on the contract plan. The corporation of the........ of ...., does not guarantee, however, that the materials to be excavated will be even approximately like that indicated on the contract plan. Intending bidders will be permitted to dig additional test pits at their own expense under the supervision of the Engineer of the .... of .... providing all conditions regarding safety of the existing works.

22. The following documents and plans are parts of this contract and are held of equal force and effect:

(*a*) The advertisement for proposals as published in the papers.
(*b*) Proposal for bids.
(*c*) Bid or Estimate.
(*d*) Bond.
(*e*) Contract and Specifications.
(*f*) The approved drawings and plans furnished by the .... of the .... of ....

DEPARTMENT OF THE PROVINCIAL SECRETARY

THE PROVINCIAL BOARD OF HEALTH OF ONTARIO

2. STANDARD BOND, 1917

The proposed sewers for the .... of ....

This Bond refers to Contract for ....
....
....
....
....
....
....
....
together with all work incidental thereto.
Date of Contract ....
Date of order to commence ....
Date of work to be completed ....
Date of Completion ....
Name of Contractor ....
....
Name of Sureties ....
....

Surety Bonds usually cost the Contractor one half (½) per cent. of the amount of the contract, per annum, and provide surety of fifty (50) per cent. of the contract price.

If maintenance clauses are in the contract additional rates are charged amounting usually to twenty-five (25) per cent. per annum of the first premium.

BOND

KNOW ALL MEN BY THESE PRESENTS, That we ....
....
.... as Principal,
and . . ..
....
....
....
as Sureties, are held and firmly bound unto the ....
of .... in the sum
of .... Dollars,
for the payment of which, well and truly to be made, we do hereby jointly and severally bind ourselves, our heirs, successors and administrators, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH, That, whereas, the said above named principal .... did on the .... day of .... 191 , enter into the foregoing agreement with the .... of .... which said agreement is made a part of this bond the same as though fully set forth therein.

NOW, if the said part .... of the second part of the said foregoing agreement, shall well and truly execute all and singular the stipulations of said agreement by .... to be executed, and shall pay all just and legal claims for labour performed upon, and for materials and machinery furnished for the work specified in the said agreement, this obligation to be void, otherwise to remain in full force and virtue in law; we agreeing and hereby consenting that this undertaking shall be for the use of any labourer or material man, having a just claim as aforesaid, as well as for the .... of ...., and, further, that the parties to the foregoing agreement may from time to time and, as often as they see fit, make any addition to, omissions from, or modification of the work and the said agreement, which in the judgment of the said parties do not materially increase the liability thereon, without consulting the sureties thereto, and without in any way affecting their liability hereon.

WITNESS OUR SIGNATURE, this .... day of ....
191 .

....
Principal

....
Principal

....
Principal

....
Principal

....
Surety

Business ....
Residence, No. .... Street.

....
Surety

Business ....
Residence, No. .... Street.

....
Surety

Business ....
Residence, No. .... Street.

....
Witness

....
Witness

Signed in the presence of

....

....

DEPARTMENT OF THE PROVINCIAL SECRETARY

THE PROVINCIAL BOARD OF HEALTH OF ONTARIO

3. Standard for Bids and Estimates, 1917

Proposal ....
....
....
....
....
....
....
....
....
....
....
....
together with the work incidental thereto.

The bidder's name and residence must be inserted here, and in case of firms, the name and residence of each and every member of the firm must be inserted

BID OR ESTIMATE by ....
residing at (or place of business) ....
and ....
residing at (or place of business) ....
composing the firm of ....
....
or .... a company
duly incorporated by the ....
and having their head office at ....
To the .... of ....

1. DECLARE THAT
of lawful age and the only person interested in this bid; and no person other than herein above named has any interest in this Bid or in the contract proposed to be taken.

2. FURTHER DECLARE that this Bid or Estimate is made without any connection, knowledge, comparison of figures or arrangement with any other person or persons making a bid for the same work, and is in all respects fair and without collusion or fraud.

3. FURTHER DECLARE that no member or officer of the .... of the .... of ...., shall be or become interested directly or indirectly, as a contracting party, partner, stockholder, surety or otherwise in or in the performance of the contract, or in the supplies, work or business to which it relates or in any portion of the profits thereof, or of any such supplies to be used therein, or in any of the moneys to be derived therefrom.

4. FURTHER DECLARE that the several matters stated in the said Bids are in all respects true.

5. The undersigned having carefully examined the locality and site of the proposed works, as well as all the plans, drawings, profiles, Engineer's estimate of quantities, proposal for bids or estimates, bid and estimate, schedule of prices, bond, contract and specification, and all the clauses in the specifications and general conditions, hereby accept the same as part and parcel of this contract, and do hereby bid and offer to enter into a contract to construct the said ....

....

....

Insert here proper de- scription ac- cording to general word- ing of page 255

....

....

....

....

....

....

....

....

together with all the work incidental thereto and the removal of all rubbish immediately after the completion of each section, as hereinafter provided; the providing for the present drainage; also all loss or damage arising out of the manner of constructing the work aforesaid, or from the action of the elements or from any unseen obstructions or difficulties which may be encountered in the prosecution of the same and all expenses incurred by or in consequence of the suspension or discontinuance of the work as hereinafter specified, and of a faithful compliance with each and every provision of the specifications for the work, the following prices, viz:—

NOTE.—In case a bid shall be submitted by or on behalf of any Corporation, it must be signed in the name of such Corporation by some duly authorized officer, or agent thereof, who shall also subscribe his own name and office; if practicable the seal of the Corporation should be affixed.

....
....
....
....
....
....

(In the above blank shall be written the extent of the contract, that is, whether several projects are included as one, or a single project, or several projects severally.)

The distinct understanding being that the whole work, comprised under the afore-mentioned heading, including contingencies, is to be completed for the sum bid, except that should any additions to or deductions from the work be made, the price shall be added to or deducted from the contract sum as the case may be and in making additions the Engineer shall adopt the municipal rate shown in the Schedule of Measurement, and in making deductions he shall make them on the basis of fifteen (15) per cent. less than the municipal rates.

The contractor shall be paid in the following manner, viz.:—80 per cent. of the value of the complete work in accordance with the progress certificate of the Engineer (the Engineer's Progress Certificate to include invoice cost of material delivered on contract less 20 per cent.) to be paid monthly on or before the .... day of each month. Upon completion of the contract, and conditions thereof, the balance then due less 5 per cent. to be paid within thirty days after presentation of the Engineer's final certificate that the contract is complete. The remaining 5 per cent. to be paid subject to the conditions of this contract sixty days after completion of contract.

5. AND ALSO AGREE, if this Bid is accepted, to execute whatever additional work together with such changes as may be ordered at the municipal rates, as specified in the Proposal for Bids, in strict conformity, in all respects, with the requirements of the specifications, general conditions and form of agreement.

In arbitrating extra work not provided for in Proposal for Bids including overhead and plant depreciation, agree that the sworn cost plus 15 per cent. is a just and equitable compensation.

6. And further agree that this offer is to continue open to acceptance until the formal contract is executed by the successful bidder for said work.

7. And, if this Bid is accepted, the undersigned agree to execute the contract and Bond in triplicate within five days after being notified so to do by the .... of the .... of .... And in the event of default or failure on .... part so to do ....agree that the .... of the .... of .... shall be at liberty to retain the money deposited by .... to the use of the .... of .... and to accept the next lowest of any Bid, or to advertise for new Bids; or to carry out the

works in any other way they may deem best; and .... also agree to pay to the said .... of the .... of .... the difference between this Bid and any greater sum which the said Corporation may expend or incur by reason of such default or failure, or by reason of such action, as aforesaid, on their part, including the cost of any advertisement for new Bids; and to indemnify and save harmless the said corporation and the .... from all loss, damage, cost, charges and expense which they may suffer or be put to by reason of any such default or failure on .... part.

8. And agree that the awarding of the Contract based on this Bid, by the .... of .... shall be an acceptance of this Bid without communication or notice thereof to

9. And propose Mr. of the of and Mr. of the same place, as sureties, who are willing to become bound with the undersigned for the due performance of the Contract, for which this is a Bid.

Name

Address.

Contractor's Signature } Name
Address

Witness

10. The undersigned hereby offer to become bound for the above named contractor in the usual bond for the fulfilment of the above-mentioned Contract if awarded to ....
....
and further agree that if the contractor shall omit or refuse to execute the same, they will pay to the .... of the .... of .... any difference between the sum to which the said contractor be entitled upon its completion and that which the .... may be obliged to pay to the party to whom the contract may be awarded at any subsequent letting; the amount in each case to be calculated upon the estimated amount of work by which the Bids are tested.

Signatures of Sureties. }

Witness ....

Name .... and
Name .... and
Name ....
being each for himself duly sworn, says that he is owner of real estate in the .... worth the sum of .... ($) over and above all liabilities and encumbrances of every nature.
Sworn before me, this .... day of .... 191 .

....
Commissioner or Notary Public.

TO WIT:

DOMINION OF CANADA
County of } IN THE MATTER of a proposed Contract for

Do solemnly declare that the several matters stated in the above Bid are in all respects true.

And make this solemn declaration conscientiously believing it to be true, and knowing that it is of the same force and effect as if made under oath, and by virtue of "The Canada Evidence Act, 1893."

SEVERALLY DECLARED before
me at the of
in the County of this
day of 191 . }

A Commissioner, etc.
(Or Notary Public.)

DEPARTMENT OF THE PROVINCIAL SECRETARY

THE PROVINCIAL BOARD OF HEALTH OF ONTARIO

4. STANDARD CONTRACT, 1917

Description

together with the work incidental thereto.

The foregoing Bid, including Prices and Payment and the general Conditions form our agreement with the.. of .... dated .... 191 together with the bond or security, the Proposal for Bids, the Specifications attached thereto, and the plans and the documents referred to in the said agreement, and the said agreement, form our contract in this matter.

The Corporation of the

of

....

Contractor.

....

....

Date.

....

Witness.

DEPARTMENT OF THE PROVINCIAL SECRETARY

THE PROVINCIAL BOARD OF HEALTH OF ONTARIO

5. Specifications Including the Standard General Clauses, Sections 1-57 inclusive, 1917

Covenant

1. WITNESSETH, that the parties to these presents, each in consideration of the agreements on the part of the other herein contained, have agreed and hereby agree, the party of the first part for itself, and the party of the second part for itself, or himself (themselves) his or their executors, administrators and assigns, as follows:

Contract

2. The "Contract" shall be understood to mean the signed document, including the Proposal for Bids or Estimates, the Bid or Estimate, the Bond, Contract, the specification, the general conditions, and the signed drawings relating to the work embodying the complete understanding and agreement between the Principal and the Contractor. It is understood that from and after the date of the signing of the contract, all former verbal understandings or written agreements made prior to the signing of this document apart from those actually introduced and expressed in the contract are of no effect. The contract shall be understood to embody the full and complete agreement.

Protection of Agreement

3. Three (3) copies of this agreement shall be executed, one to become the property of the contractor, one the property of the Principal and the third shall be sealed and deposited in the safety deposit vault of the Head Office of the Bank of .... of .... Ontario, and the key of such vault shall be left in trust with the manager of the said bank to be delivered up to the parties or their official representatives jointly interested upon the presentation of the Certificate of the Engineer as to Completion of Contract.

4. Any matter in dispute as to liability of the Principal under this agreement shall be judged according to the Engineer's Schedule of Measurement this document and subsequent orders of the engineer, a triplicate copy of which shall require to be deposited weekly in said vault, envelopes to be marked "To the .... of the .... Bank of .... for deposit in safety deposit vault box No. ...." and shall bear a date and number on the left hand margin.

Extras

5. The words "Principal" and "Corporation" shall mean the .... who agrees to pay for the work and shall include administrators, executors and assigns.

"Principal"

6. The "Contractor" shall mean the person who agrees to do the work, and shall include the bondsmen and sureties, together with his and their heirs, administrators, executors and assigns.

Contractor

7. "Work" shall mean the whole or any part of the work to be done, or materials to be supplied under the contract, whether as originally set forth or as varied by written order of the Engineer.

Work

8. "Wages" shall be interpreted to mean the prevailing rate of wage at the date of signing this agreement and all disputes involving sums of which wages form a part shall be adjusted on this basis.

Wages

9. "Plant" shall mean all appliances or materials which shall be brought to, or constructed upon the site, also animals which may be required or used in the carrying out of the work.

Plant

10. The "Site" shall mean the place where the work is to be performed, or such place as is particularly named or described in the contract, including the approaches thereto. The sites and right-of-way thereto required for the work will be provided by the Principal and be available for the commencement of the work by the Contractor upon the date specified or as herein provided for.

Site

11. "Approved" when used in connection with, or referring to, any drawing, materials, equipment, apparatus, methods, or other things in connection with the contract, shall mean that the thing referred to shall receive the approval of the Engineer in writing before being ordered done, provided, used or constructed, as the case may be.

Approved

12. Wherever the word "Engineer" is used in the specifications or in this contract, it shall refer to and designate the .... Engineer or his assistants, designated by him to act in the premises, limited to the particular duties

Engineer

intrusted to them. The Engineer shall supply the contractor from time to time and when so requested with a statement setting forth the duties of his assistants acting on the premises. In case the .... Engineer may not be able to act, then such Engineer as may be designated by the Principal shall act in his place.

Notices

13. All notices, instructions, reports and certificates shall be in writing and signed by the party making the same.

Notices where served, mailed or delivered

The residence or place of business given in the Bid or Estimate upon which this contract is founded is hereby designated as the place where all notices, letters and other communications shall be served, mailed or delivered. Any notice, letter or other communication addressed to the contractor and delivered at the above named place or his agent in charge of the work, or deposited in a postpaid wrapper in any post-office box regularly maintained by the post-office, shall be deemed sufficient service thereof upon the Contractor. The place named may be changed at any time by an instrument in writing, executed and acknowledged by the Contractor and delivered to the Principal or his Engineer. Nothing herein contained shall be deemed to preclude or render inoperative service of any notice, letter or other communication upon the Contractor personally.

Control of work

14. The Engineer shall have the general direction and control of all and every part of the works embraced in this contract, and the same shall be carried on and completed to his entire satisfaction.

15. The plant of the contractor transferred to the site of the contract shall be considered as being the property of the Principal throughout the contract, and in case of the contractor's default may be used by the Principal to expedite the completion of the work and no plant shall be removed without written permission of the Engineer.

Plant to be returned to Contractor upon completion of the work

16. Immediately after the completion of the contract and prior to the adjustment of the several matters as to payment or liability, as the case may be, between the Principal and the Contractor, the Plant shall be transferred to the Contractor responsible under this agreement, and it is agreed that all plant which is no longer required on the work may be removed by the Contractor or upon written permission of the Engineer.

Stakes, lines and levels

17. The Contractor shall give the Engineer at least 36 hours' notice in writing before requiring any levels, lines or stakes of any portion of the works, and he shall clearly state in such notice the exact locality or localities where such are needed for immediate use. The Contractor will be held responsible for the preservation of all stakes and marks in their proper positions, and in case any of them are disturbed, lost or destroyed, after

having been given, he shall at once notify the Engineer in writing, and all expenses incurred by the Principal in replacing the same shall be charged against the Contractor and deducted or collected, as provided in Section 54 of this part. As the stakes and marks set will not in all cases represent all the grades, levels, lines and angles, or change of surface, lines or levels in the finished work, the Contractor must satisfy himself as to the meaning of all stakes, lines and levels before commencing work and shall see that they are taken and read correctly in connection with the plans, details, specifications and Engineer's directions. Should he discover or suspect any errors in the same, he shall at once discontinue work until such errors are investigated and rectified; but no claim shall be made or allowed on account of any alleged inaccuracies.

Removal of persons, plant and material

18. The Engineer may order and enforce the dismissal of any person in the contractor's employ in connection with this contract, whether for insubordination, misconduct, negligence or incapacity, and may also order and enforce the removal of any work or plant which to him appears defective or unsatisfactory and the contractor shall obey such order, and substitute approved work or plant.

Alterations

19. Alterations in the work shall be made only on the order of the Engineer.

Engineer's right to suspend work

20. The Engineer may suspend the whole or any part of the work herein contracted to be done, and during such suspension the excavation in ....
....
....
shall be refilled or sheet piled and refilled as the Engineer may require, any roadway over the same properly restored, and all materials delivered upon the work shall be neatly piled so as not to obstruct public travel, or shall be removed from the line of the work if directed by the Engineer, and unless the materials be so piled or removed, as the case may be, by the Contractor upon .... hour's notice from the Engineer, the materials will be removed by the Principal and the expense thereof deducted from the moneys due or to become due to the contractor under this agreement.

Postponement or delay

21. Should postponement or delay be occasioned by the precedence of other contracts connected with a Public Utility or Local Improvement which may either be let or executed before or after the execution of this contract on the line of the work, no claims for damages therefor shall be made by or allowed to the Contractor; except that if the Contractor shall be delayed in performance of his work by reason of the work or any part thereof being suspended as above provided, such allowance of time as the Engineer shall deem reasonable shall be made by the Principal in the manner hereinafter provided for.

In case it shall be found that for any reason the Corporation

of the .... of .... cannot enter upon any of the properties named in the contract for the purpose of constructing the works, the time for such construction on such street or property shall be postponed until the conditions are such as to permit the Corporation of the .... of .... to enter upon, occupy and use said properties for the purpose aforesaid, without prejudice to the contract, or to the right of the .... of .... to require the postponed work to be done by the Contractor under the terms of the contract, and without increased cost to the .... of .... provided that such postponement shall not exceed three months; should such postponement affect only a portion of the work to be done the contractor shall be paid for the work completed in the same manner as though the entire amount of the work named in the contract had been done and completed.

Decision final

22. The Engineer, shall, if the Principal or Contractor so request, give his decision on all matters pertaining to the work, which decision shall be final and binding on the Principal and on the Contractor.

Engineer's drawings

23. The work shall be executed in accordance with the specifications and the accompanying drawings and such other supplementary detailed specifications and drawings as may from time to time be furnished or approved by the Engineer.

Contractor's drawings

24. In all cases where the Contractor is required to submit drawings and specifications such drawings and specifications shall be approved by the Engineer prior to the commencing of the work and the work shall be executed in accordance therewith. All such drawing shall be furnished and approved in triplicate.

Shop drawings

25. In all cases where shop drawings are required the Contractor shall furnish three copies of such drawings for the examination and approval of the Engineer. One set of these drawings shall be returned to the Contractor by the Engineer after approval, one set shall be filed and one set retained by the Engineer. All such drawings and specifications and all necessary templates shall be furnished with the least possible delay by the Contractor.

Work mentioned in specifications and not shown on plans

26. Should there be any doubt as to the meaning of the specifications, Engineer's Schedule of Measurement, Municipal rates or any obscurity in the wording of them, or should there appear to be any discrepancy between them and the plan, the Engineer shall explain them.

All work and materials required for the proper performance of this contract mentioned in the specifications and not shown on the plan, and all work and materials shown on the plant and not mentioned in the

specifications, are to be furnished, performed and done as if the same were both mentioned in the specifications and shown on the plan.

Errors 27. If any errors or omissions be discovered in the Schedule of Measurement, drawings or specifications by either party to this contract, it shall be the duty of such party to bring such omission or error to the attention of the party, and no party shall take advantage thereof.

Commencement 28. The Contractor shall commence construction at the point or points given him by the Engineer, and such work shall commence on the date or dates specified by the Engineer. The work shall be carried on continuously and expeditiously after commencement and shall be completed within the time specified.

Contractor to furnish tools, etc. 29. The Contractor shall at his or their own cost and expense, and in strict conformity to the hereinafter contained or hereto annexed specifications and the plan, furnish all the material and labour, and all the scaffolding, tools, derricks, tackle, implements and appliances necessary or proper for the purpose, and in a good substantial and workmanlike manner, excavate for, build, construct and complete the above described works and appurtenances, together with all the work incidental thereto, of the dimensions, in the manner and under the conditions set forth in the agreement.

Barriers and lights 30. The Contractor shall, at his own expense, and without further or other order, provide, erect and maintain all requisite barriers, fences or other proper protection, and shall provide, keep and maintain such watchman and lights as may be necessary, in order to insure safety to the public as well as those engaged about the premises or works. He shall also provide a sufficient number of "NO THOROUGHFARE" or other proper notices which he must cause to be placed and maintained in good order in conspicuous places. When any work is carried on at night, the Contractor shall supply, at his own expense, a sufficient number of electric or other approved and sufficient lights, to enable the same to be done in an efficient and satisfactory manner, and the Engineer shall have the power to order additional lights to be put on at the Contractor's expense if, in the Engineer's opinion, they are or may be required.

Water closets 31. The Contractor shall provide and properly maintain in clean condition, suitable and convenient privy or water-closet accommodation for his men.

Employment of labour 32. The Contractor shall .... employ .... labour residing within a .... mile radius of the .... with ...... the approval and consent of the Principal or his duly authorized agent. The Contractor shall not interfere in any way with the labour or workmen employed in the ....
....

Laitance

33. "Laitance" shall mean the milky, spongy, imperfect concrete occasionally floated to the surface when working in forms. (*The material sets imperfectly and does not bond well.*)

Use of hydrants

The Contractor shall use no hydrant until he has obtained a permit issued under and subject to the regulations of the water department.

Service ground

34. The Contractor shall provide all lands for storage of plant and materials required for prosecuting the contract.

Delivery of materials

35. Materials furnished by either party shall be provided in such quantity and at such times as may be necessary for the proper prosecution of the works.

Notwithstanding the foregoing clause non-delivery of material by the Principal shall not constitute a right of the Contractor to damages, but shall constitute a right to an extension of time for completion of contract where the Engineer, after inquiring, reports in writing that such claim is reasonable and just. The allowable extension of time shall be mentioned in said report and shall become binding upon the Contractor.

Wages

The Contractor shall pay his workmen not less than the prevailing rate of wages in force during the execution of the contract, and such workmen shall be paid at least twice per month.

Hours

36. The number of hours out of the 24-hour day which a workman shall actually work or receive compensation for shall be such as are specified by law or otherwise by custom, except for the protection of life or property or other emergency when the necessity therefor is confirmed by the Engineer.

Superintendent

37. The Contractor shall, throughout the progress of the work, employ at least one competent superintendent who shall remain constantly on the site during working hours to superintend the work, who shall be the Contractor's representative to receive and carry out orders and instructions from the Engineer.

Foreman

38. The Contractor shall, through the progress of the work, employ at least one competent foreman in each of the various trades who shall remain constantly on the site during working hours to supervise the work of that trade.

Work not provided for in contract

39. Should it become necessary, before the completion of the work contemplated herein, to do any other or further work on or about these works than is provided for in this contract, the Contractor shall not in any way interfere with or molest such other person or persons as the Principal may employ to do such work, and will suspend such part of the work herein specified, or will carry on the same in such manner as may be ordered by the Principal, to afford all reasonable facilities for doing such work; and no other

damage or claim by the Contractor shall be allowed, except such extension of the time for the performance of this contract as the Engineer may deem reasonable.

Safety

40. The Contractor shall conform to all requirements of the Provincial, Municipal and Dominion authorities respecting the safety and convenience of his employees, and shall assume the responsibility of the Employer Liability Act as to this contract.

Sub-letting

41. The Contractor shall not sub-let or assign this contract or any other part of the work without the consent of the Principal.

Damages

42. The Contractor shall be responsible and liable for all damages or injuries to persons or property, due directly or indirectly to defects in the design or construction of the works embraced in this contract, and shall not be relieved of such responsibility except where the Contractor can show that he has applied to the Principal for revision of design and where the same is refused in writing. Delay in replying to such application shall entitle him to an extension of time where it can be shown said delay interferes with the programme of the Contractor's work.

In carrying out the works from their inception, and until the final acceptance of the same, the Contractor must be careful to cause as little injury or damage as possible to any adjacent property, public or private, or to any sidewalks, roadways, curbs, gutters, manholes, frames, covers or street gulleys, boulevards, grass plots, sodding, trees, shrubs or any other structures, works or things on or near the line, or in the vicinity of the works or elsewhere, and he must make good the same, at his own expense, in the manner directed by, and to the satisfaction of the Engineer.

Claims for labour, etc.

43. The Contractor shall pay promptly, and in cash, for all labour employed upon and for materials furnished and used in the work, and the work shall be done and managed by and at the cost of the Contractor so as not to violate any law or ordinance and so as not to damage or injure the property of any other person. If at any time before or within thirty days after the whole work herein agreed to be performed has been completed or accepted by the Principal, any person or persons claiming to have performed any labour or furnished any material towards the performance or completion of this contract shall file with the Principal any such notice of lien or claim as is described in the Act respecting Liens of Mechanics, wage earners and others and in the Act respecting Conditional Sale of Goods, vide Statutes of Ontario, then, and in every such case, the Principal shall retain anything herein contained to the contrary notwithstanding, from the money under his control, and due and to become due under this agreement, so much of such money as shall be sufficient to pay off, satisfy and discharge the amount in such notice alleged or claimed to be due to the person or persons filing such notice, together with the reasonable cost of

any action or actions brought to enforce such lien or the claim created by the filing of such notice. The moneys so retained shall be retained by the Principal until the lien or claim thereon created by the said Acts and the filing of said notice, shall be discharged pursuant to the provisions of the said Acts.

Royalties and patents

44. Should the Contractor use or supply any patented article, or any patented process in this work he shall be responsible for all payments of royalties and other charges connected therewith, and will save harmless the Principal from or against all claims, injunctions, suits, costs, damages and expenses arising therefrom, but should any article or process be shown or called for by the plans and specifications which form part of this contract, the patent of which is in dispute and the Contractor purchase the same in the open market with the written consent of the Principal, then the royalties or other charges connected therewith shall be borne by the Principal, unless otherwise specially agreed and the Principal shall save harmless the Contractor from all claims arising therefrom.

Inspection

45. The Contractor shall permit the inspection of all materials, workmanship and plant by the Engineer at all times during the progress of the work, and shall provide the necessary facilities and assistance therefor.

Pro. Inspector's powers

46. Inspectors shall be on the ground during all working hours, upon the receipt of a written application from the Contractor the Engineer shall provide such additional inspection as is required in order not to hamper the work of the Contractor. Inspectors are required to see that the provisions of the specifications are faithfully adhered to, especially as regards the quality of the workmanship and materials, and shall have the power to suspend any workman for incompetency, drunkenness or negligence. An Inspector may stop the work entirely if there is not a sufficient quantity of suitable and approved material on the ground to carry it on properly or for any other good and sufficient cause. Any work done in the absence of an Inspector may be ordered to be opened up for thorough examination, and must be rebuilt or replaced as directed, and at the Contractor's sole expense. No approval by an Inspector shall be taken as, or construed into an acceptance of defective or improper work or material, which must, in every case be removed and properly replaced whenever discovered at any stage of the work. Inspectors have not the power to set out work, or give any stakes, lines gauges, levels or grades. Any orders or directions other than as herein provided for, except ....
....
....
given by Inspectors shall not be binding upon the Contractor.

Defects

47. The Contractor shall, upon being so directed by the Engineer, remove, reconstruct or make good, without extra charge, any and all defective materials and workmanship.

Protecting unfinished work

48. All unfinished masonry of whatever description shall be properly protected from injury and from water or frost.

Maintenance

49. The Contractor shall be responsible for all defects which may develop in the work under normal use during a period of .... after date of the Engineer's final certificate. He shall immediately remedy such defects free of charge when the Engineer shall have given him notice so to do. He shall also be liable for all damages caused by such defects.

Account of material and labour

50. The Contractor shall submit a weekly statement sworn to by his superintendent or other authorized agent, of all material received upon the works. The same shall be written legibly upon a form supplied by the Principal and shown herein marked Appendix "A."

The Contractor shall submit two weeks after the date of receipt of the progress certificates a statement sworn to by himself or his authorized agent, of all material or labour paid for or upon which the Contractor has no further liability. The said statement shall bear the dates when material was ordered, date received, date upon which Contractor's liability was discharged: when only partly discharged against a bill of material a copy of the said bill of material shall be included as appendices and referred to on the statement by suitable reference; the proportion of total liability discharged shall be shown on the statement which shall be upon a form (shown in Appendix "B") supplied by the Principal for the Contractor's convenience.

51. Progress Certificates shall be issued by the Engineer during the continuance of the work, based upon the agreed percentage of the value of the work done as set out in the contract and notice to bidders.

In case of bulk sum contracts, coincident with the signing of the contract, the Contractor shall revise the Engineer's schedule of measurements and insert unit values for the various parts of the work covered by the schedule aggregating the total sum of the contract, and if required he shall submit evidence supporting his unit values. The schedule and the Contractors unit values, together with the material received on the site, shall be used as a basis for preparing progress certificates of payment.

Progress certificates

The progress certificates or payments made thereon shall not relieve the Contractor of any of his obligations under the contract nor prejudice the rights of the Principal against the Contractor, or vice versa, nor shall they be construed as a final acceptance of the works or any portion of the works.

Amending certificates

52. Should the Engineer consider it necessary he may by any certificate correct or modify any certificate previously issued by him except as provided in section 51.

Payments and credits

53. No payments or credits by the Principal to the Contractor shall be made unless a certificate shall have been previously given by the Engineer.

Costs and charges

54. Any expenses, costs and damages which are chargeable to the Contractor and which the Principal may have paid, or be liable to pay, or which may have become forfeited to him, shall be paid to the Principal by the contractor on the Engineer's certificate, or shall be deducted by a certificate of the Engineer from amounts due or to become due to the contractor.

Forfeiture of contract

55. If the work shall be abandoned, or if at any time the Engineer shall be of the opinion, and shall so certify in writing to the Principal that the said work or any part thereof, is unnecessarily delayed, or that the Contractor is wilfully violating any of the conditions and covenants of this contract, or executing the same in bad faith, the Principal may notify the contractor to discontinue all the work, or any part thereof, by written notice to be served upon the Contractor, either personally or by leaving said notice at his residence or with his agent in charge of the work; and thereupon the Contractor shall discontinue the work, or such part thereof, and the Principal shall have the right to contract for the completion of the work or to place such and so many persons as he may deem advisable, by contract or otherwise, to work at and complete the work herein described, or such part thereof, and to use such materials as he may find upon the line of the work, and to procure other materials for the completion of the same, and to charge the expense of the labour and material to the Contractor; and the expenses so charged shall be deducted and paid by the Principal out of such moneys as may then be due or may at any time thereafter grow due to the Contractor under and by virtue of this agreement or any part thereof; and in case such expense shall exceed the sum which would have been payable under this contract if the same had been completed by the Contractor, he shall pay the amount of such excess to the Principal. In case such sum shall be less than the sum which would have been payable under this contract if the same had been completed by the Contractor, then the Contractor shall forfeit all claim to the remainder; and when any particular part of the work is being carried on by the Principal, by contract or otherwise, under the provisions of this clause of the contract, the Contractor shall continue the remainder of the work in conformity with the terms of this agreement and in such manner as in nowise to hinder or interfere with the person or persons or workmen employed as above provided by the Principal, by contract or otherwise, to do any part of the work, or to complete the same under the provisions of this clause of the contract.

Principal to have power to finish work

Bribery

56. Should the Contractor or any of his agents give or offer any gratuity to, or attempt to bribe, any Inspector or Agent of the .... the Principal shall be at liberty to take the whole or any part of the works out of the hands of the Contractor, under the same provisions as those specified in Forfeiture of Contract.

57. After satisfactory tests of the work as a whole, and after the

completion of the specified term, if any, of the operation of the work after its completion, and when the Engineer is of the opinion that the work has been completed in a satisfactory manner and the Contractor's statement or statements have been received and when the Engineer has ascertained that all claims, liens and other liabilities if any, have been satisfactorily disposed of, he shall issue to the Principal and to the Contractor his final certificate, setting forth his acceptance of the work and the amount remaining to be paid to the Contractor, and thereupon the contract shall be considered as having been completed and the work accepted by the Principal. Nothing contained in the final certificate, however, shall be construed as relieving the Contractor of his guarantee as set forth herein against defects in the work, and his obligations covering infringements of protected rights and claims and damages.

Final certificates

No final certificate will be issued until the Contractor delivers to the Principal a statement or statements in writing and, as provided for under section 50 setting out fully the amount, kind and quality of the several materials used and incorporated into the work herein required to be done; said statement or statements to be sworn to by the Contractor before a Commissioner or other Officer authorized to administer oaths. It is further agreed that the Engineer shall have a reasonable time in which to verify the accuracy of such sworn statement or statements before such final is issued.

EXCAVATION

Grubbing and clearing

58. The Contractor shall grub and clear the surface over the trench wherever it may be necessary and shall carefully lift, lay aside and replant young trees and shrubs in the line of work and remove from the ground all surplus material of whatever nature or kind.

Width of paving to be removed

Where the work is done in open trench, the Contractor shall remove the paving for such width as the Engineer may direct; the repaving of which will be done at the expense of the municipality, but in case the Contractor removes the paving for a greater width, or in case he removes any paving on account of slides or caves, or in making excavations outside of the lines of the work without the written order of the Engineer, the Corporation may retain from any moneys due or to become due to the Contractor, the cost of permanently replacing the pavement so removed at the municipal rate set forth in the "Schedule of Measurement" herein provided.

Removing paving tunnel shafts

Where the work is done in tunnel, the Contractor shall remove pavement at the location of the shafts as shown on contract drawings, together with that from such other locations as are approved of by the Engineer, and these shaft openings shall be repaved at the municipality's cost and expense, but if through any carelessness of the Contractor cave-ins occur, the municipality shall permanently repave all sunken and broken pavement resulting from such carelessness, and the cost of the extra paving shall be borne by the Contractor. The amount deducted for extra repaving shall be as shown in the municipal rates under Schedule of Measurement.

Paving material removed

59. The Contractor shall properly classify the materials removed, separating them as required by the Engineer; and shall properly store, guard and preserve such as may be required for future use in back-filling, surfacing, repaving or otherwise.

Width of trenches

60. The trenches shall be six inches, unless otherwise specified, wider on each side than the greatest external width of the sewers intended to be laid in them, but in no case shall they be less than twenty-two inches wide, and the bottom of the trenches shall be excavated so as to conform to the exact size and shape of the lower ⅓ of the sewer to be laid therein, as shown on the plans, or to the foundation under the sewer except when directed otherwise in writing by the Engineer.

The top width of the trench shall be the minimum width that will permit the proper building of the sewer and sheeting of the trench, should the latter be necessary, and shall exceed the bottom width, where two tiers of sheeting are employed only by the thickness of the necessary check pieces and sheeting.

When necessary, on account of change in plan, the Contractor shall excavate the trench to such additional width or depth as the Engineer may direct, in writing, receiving for such extra width or depth compensation on the basis of extra work; but all slides and caves shall be at the cost of the Contractor, and he shall refill without charge any cavities so caused with suitable and satisfactory material.

Obstructions notifiable

61. If any sewers, drains, connections, basins, inlets or culverts, water mains, gas mains and conduits, or any other structure having to do with a public, or private service, are encountered within the lines of this work, the Contractor shall at once notify the Engineer, in writing, of the locality and circumstances, and the place shall be passed over until satisfactory arrangements are made, and the Contractors shall not be entitled to any extra compensation, either by reason of the obstruction or from delay, but shall be allowed such extension of time as the Engineer may direct. Provided the Contractor shall not be responsible for any additional costs in the performance of his contract by reason of the ....

....

....

....

and sections ....

.... shall not apply to this contract.

Contractor to take risks

62. The Contractor shall take all risks and be responsible for all expense and damage attending the presence or proximity of any gas or water pipes, public or private sewers or drains, subways, conduits and all other underground structures which cross or appear in the trench or tunnel or are parallel with or adjacent to, but outside of, said trench, or tunnel.

Obstructions to be uncovered

63. Should the location or position of any gas or water pipe, public or private sewer or drain, subway, conduit, railway or other structure be such as, in the opinion of the Engineer, to require its removal, realignment or change, such removal, realignment or change shall be without cost to the Contractor for the work of removal, realignment or change only, but such structure shall be stripped or uncovered and supported or sustained by the Contractor, at his own cost and expense, before such removal or before and after such realignment or change, as constituting part of his contract; and the Contractor shall not become entitled to claim any damage or extra compensation from or on account of the presence of such structure or on account of any delay due to removal or rearrangement of the same, but the Contractor shall be entitled to such an extension of the time for the completion of this contract as the Engineer shall decide that the work has been delayed by any delay in the removal, realignment or change of any such obstruction.

The Contractor shall, at his own cost and expense, loosen and remove all paving material and earth between the rails and over and around ties of any and all tracks requiring removal, as being part of the work called for in the stripping or uncovering of obstructions.

Protection, removal of obstruction by companies

64. The Contractor shall not cause any hindrance to nor interfere with any individual, Municipal Department, gas, railroad or other company or companies in protecting its or their mains, pipes, poles, posts or other structures, nor in shifting, removing or replacing the same; but the Contractor shall suffer the said individual, City Department, company or companies to take all such measures as they deem wise or as may become necessary for the purposes aforesaid.

Water and gas pipes, etc.

65. All iron water and gas pipes and other structural materials, excepting as otherwise specified herein, which it becomes necessary to remove, shall be considered the property of the Corporation, and left in such part or parts of the streets as the Engineer may direct, unless notice to the contrary is given in writing by the Engineer to the Contractor, in which case the same shall be removed or otherwise disposed of at the cost and expense of the Contractor.

Obstructions requiring new trench

66. In case an obstruction requires a new trench location, the Contractor will be paid for excavation made in the abandoned trench, and for any temporary repavement required, as extra work.

Protection of water pipes

67. The Contractor shall protect all water and service pipes from freezing, and he failing to do so, the Waterworks Department shall be, and is hereby authorized to protect such mains and service pipes, or in the event of their having suffered injury, to immediately replace such pipes or to recaulk and repair the same, and the cost thereof shall be charged to the Contractor;

the cost so charged to the Contractor shall be deducted from any sum or sums due or that may become due the Contractor under this contract, upon written notice from the Waterworks Department that any bill rendered the Contractor for such replacement and repairing is due and unpaid.

Poles and posts

68. Poles or posts of any description coming within the line of the trench will be removed and replaced without cost to the Contractor.

Length of trench to be open at one time

69. Not more than three hundred (300) feet of trench shall be open at any one time, except where so ordered by the Engineer, and the length of trench open, beyond the finished section of the sewer, shall be subject to the approval of the Engineer. The excavation of the trench shall be fully completed at least twenty (20) feet in advance of the construction of the invert, unless otherwise ordered.

Surplus material, how disposed of

70. In case more material is excavated from the trench than can be disposed of on the street the surplus material shall be carried away to some convenient place to be provided by the Contractor and when the sewer shall be built, the material, if of the proper kind shall be brought back and the trench properly filled, the cartage and storage being at the Contractor's expense. All surplus material or any portion thereof, excavated from the trenches shall, if required, be deposited on the streets and avenues within the limits of this contract where the streets are below grade, and in such manner as to leave the surface of the same even, to the satisfaction of the ....

Locations where superfluous earth may be deposited

71. Superfluous earth and other material from the trenches and excavations may be deposited ....
....
or at such other points as the Engineer may direct; provided that the average haul of the same shall not exceed that to the place named.

If required to be hauled a greater distance than one mile, an extra allowance of three-quarters of a cent per cubic yard per hundred feet will be made to the Contractor.

Material not to be sold without permission of the Engineer

72. The Contractor shall not sell or permit to be removed from the line of the work, before the trench shall have been refilled, any building sand or earth excavated therefrom, except upon the written permission of the Engineer and then only so much as shall remain after reserving a sufficient quantity to refill the trench and complete the paving, but he will in all cases refill the trench with the same material thrown out, provided it be good sand, gravel or earth; but if it be unsuitable, consisting of rock, blasting stones, mud or top soil, then the same shall be removed from the ground, and good clean

earth procured and used for refilling the trench, and sand of proper quality and depth spread on the surface, to receive the re-pavement.

Excavation in built-up districts

73. In built-up districts or in streets that are thoroughfares, the material excavated from the trench for the first 100 feet in length shall be carted away by the Contractor as soon as excavated, and the material subsequently excavated shall be used to fill in the trench where the sewer has been built. This is done so as to insure that there shall be no surplus material lying on the line of the street at any time during the construction of said sewer. Any extra material required for filling at the completion of the work shall be procured by the Contractor at his own cost and expense, and at all times the gutters shall be kept open for surface drainage, and the street and sidewalks shall be kept clear and free for the passage of carts, wagons, carriages and street or steam railway cars or pedestrians, unless otherwise authorized by special permission in writing from the Engineer.

Hauling material on streets

74. When it is necessary to haul soft or wet material over the streets or pavements of the city, the Contractor shall provide suitable tight wagons, approved by the Engineer so as to prevent deposits on the streets or pavements. In all cases where any materials are dropped from the wagons of the Contractor he shall clean up the same as often as directed and keep the sidewalks clean and free from dirt and mud.

Bridging trench at crosswalk and on line of work

75. Where any crosswalk is cut by the trench it shall be temporarily replaced by a timber bridge at least three feet wide, with side railings if so ordered; no allowance will be made therefor. When in the opinion of the Engineer it is necessary to construct a bridge for wagons, at street intersections or on the line of the work, the Contractor shall build and maintain the same, and no allowance will be made therefor. The work shall at all times be conducted so as to cause as little inconvenience as possible to public travel and access to private or public property on the line of the work.

Work to be done at night

76. Whenever, in the judgment of the Engineer, it may be necessary or expedient, in order to interfere as little as possible with any street or steam-railroad, and to preserve and maintain traffic over or on any tracks, or over or on any street or road, to do work at night or after or before the regular time of ending or beginning labour, such night or overtime work shall be performed by the Contractor without additional or extra cost to the Corporation beyond the price bid for the work. The Contractor shall provide such and all lights as the work may require and as the Engineer may deem necessary for the proper and expeditious carrying on of the work.

Contractor to protect and support buildings, fences, etc.

77. The Contractor shall at his own cost and expense shore up or otherwise support or protect any buildings, bridges, walls, fences, pavements or other structures which may show defects or which, in the opinion of the Engineer or the Contractor, may be liable to injury or to be endangered during the work; and in case of injury, damage or disturbance to any buildings, bridges, fences, walls or other structures during the construction of the sewer herein contracted for whether directly or indirectly by and because of the construction of said sewer or of any extra work entering into this contract, the Contractor shall at his own cost and expense proceed to restore, repair, rebuild or otherwise make good the damage, injury or other disturbance so noted, and put the said buildings, fences, walls or other structures in a condition the same as or equal to that existing previous to his beginning the work.

Dangerous contin-gencies

78. The right is reserved by the Corporation for the Engineer to direct the manner in which the excavation shall be proceeded with and adjoining structures protected in the event of encountering quicksand, subsurface streams, or similar dangerous contingencies, and section 42 shall apply.

Contractor responsible for railroads

79. The Contractor, in addition to the other risks of the work, shall take all risks and be responsible for the safety and integrity of all street or steam railroads encountered in his work, and for damage thereto of any kind and character, and shall take all necessary precautions to avoid injury to the roadbed or tracks of such railroads, and any unnecessary delays or interruptions to traffic.

Street railway

80. In the event of the sewer lying parallel with or adjacent to, or crossing the line and track or tracks of any street railway, the Contractor shall alone be responsible for the support of said track or tracks in such manner as to continue traffic thereon in a safe and regular manner. He shall place stringers and other timbering (and piling where necessary) and do all other work necessary to sustain tracks in a proper and safe condition to the satisfaction of the Railway Company and the Corporation. The cost of said support being borne by the Contractor as a part of his work under this contract.

In case of settlement of, or injury to, the tracks or other structures belonging to said street railway, as a consequence of the neglect or refusal of the Contractor to support said track or tracks, or because of the inadequate, insufficient or otherwise unsuccessful method or means of support employed, then the Contractor shall proceed, upon receipt of written notice from the Engineer, to realign, regrade, resurface and repave such track or tracks and restore the same to the condition existing before beginning work, or to a similar condition; and in the event of the Contractor's neglecting or refusing to commence

making such repairs immediately after receipt of such written notice, then the Engineer may proceed to realign, regrade, resurface, repave and restore said track or tracks as above provided, and the cost thereof will be deducted from any moneys due or to become due the Contractor under the contract.

Steam railways

81. In the event of the sewer lying parallel with or adjacent to, or crossing the line and tracks of the Grand Trunk, Canadian Pacific, Canadian Northern or other Railway Company, the said Railway Company will drive piles and place stringers and braces for the support of their tracks at the expense of the Corporation. The Contractor shall then be permitted to enter upon the right-of-way in order to perform the work necessary for the carrying out of this contract.

Should there be a settlement of, or injury to, the tracks or other structures belonging to the said steam railways, as a consequence of the neglect or refusal of the Contractor to properly sheet his trenches or otherwise support the ground through which the trench is excavated, or because of the inadequate, insufficient or otherwise unsuccessful means of support employed, then the Contractor shall proceed (upon receipt of a written notice from the Engineer) to realign, regrade, resurface and ballast such track or tracks and restore the same to the condition existing before beginning the work, or to similar condition; and in the event of the Contractor neglecting or refusing to commence making such repairs immediately after receipt of such written notice, then the Principal may proceed to restore said tracks as above provided, and the cost thereof will be deducted from any moneys due or to become due Contractor on this contract.

Presence of inspector

82. The presence of an inspector employed by any street or steam railway company shall not relieve the Contractor of responsibility.

Manner of crossing railroads

83. When any street or steam railroad lines are to be crossed or interfered with, directions as to the time and general manner of doing this work will be given by the Engineer, but the Contractor, in addition to other risks of the contract, shall be responsible for all risks and damages attending such work.

Responsibility and payment where tracks have to be removed

84. Should the required location of the sewer be under and parallel with any such railroad track as to require the temporary removal of such track or tracks during construction, such track or tracks will be removed and relaid without cost to the Contractor for the actual work of removal and replacing. The Contractor shall be responsible, however, for any damage or injury to the roadbed due to improper construction or back-filling.

Culverts and receiving basin

85. All excavations for culverts and receiving basins in earth are subject to these specifications for trenches.

Excavations for bell-mouths, etc.

86. Excavations for bellmouths and other junctions, storm or overflow chambers and other appurtenances of the sewer shall be made at the points shown on the plans. Such excavations shall be of the necessary widths and depths, and shall be made in all respects in accordance with the requirements of these specifications.

Tunneling

87. The Contractor shall not excavate for the sewer in tunnel, except as provided in the contract drawings, without the Engineer's permission in writing, and the location of all shafts shall be subject to the approval of the Engineer. Notwithstanding anything to the contrary the Contractor shall not excavate for the sewer in tunnel unless all necessary materials are provided, and the manner of carrying on the work is satisfactory, for the proper support of the sides and roof of the tunnel and for maintaining the specified cross section throughout construction.

PILING, SHEETING, SHEET PILING, BRACING, SHORING, ETC.

88. The price paid per lineal foot of sewer shall include the cost of all temporary supports, sheeting and braces that may be necessary for the proper protection of the work, the adjacent streets, buildings or other improvements and to secure a safe prosecution of the work until the permanent structure is complete; such temporary supports must in all cases be removed by the said Contractor at his own expense after or concurrently with the completion of the permanent structure, except as provided for in these specifications.

Piles

89. If in the opinion of the Engineer piles are required in other places than shown on the plans or that may be mentioned in the specifications, the Contractor must drive the same when and where ordered by the Engineer. The extra piles thus ordered by the Engineer will be paid for at the municipal rate mentioned in the "Schedule of Measurement."

Quality and size piles

90. All piles shall be straight and of sound pine, cedar, spruce or tamarac at least six inches in diameter at the points and not less than ten (10) inches in diameter at the butts where cut off.

Piles, how paid for

When a price per foot is bid for piles, the length driven from the required grade to the point of the pile will be paid for at the prices bid per foot. The portion of the pile cut off above the required grade will not be allowed for in the measurement, except the length cut off be less than four feet, in which case the length from the underside of the cap to the point of the pile will be paid for.

Test piles

91. The necessary length of piles to be used may be determined by driving test-piles at such points and in such manner as the Engineer may direct, and the length of such test piles in the ground will be paid for at the municipal rate in the Schedule of Measurement.

Driving

92. Each pile shall be in one piece of sufficient length to reach to the required depth. They shall be trimmed close and all loose bark removed before driving; the small end shall be pointed and the butt end squared as directed; they shall be driven to such refusal as the Engineer may direct. All the piles shall be protected from the blows of the hammer by a wrought iron ring if necessary; should the heads of the piles be split or hammered by the driving, the portion split or broomed shall be cut off so as to utilize the full force of the blow of the hammer; any pile that may be broken in the driving or any pile that the Engineer may direct to be drawn, shall be at once drawn and a new pile driven in the place thereof.

Cutting to grade

93. After being driven the heads of the piles shall be cut off true to the grade given by the Engineer; where it is necessary to cut off the heads of piles below water no extra compensation will be made for such cutting.

Shoring

94. The sides of the excavation shall be supported by suitable planking and shoring wherever necessary. In case the distance between faces of the sheeting is less than that called for by the width of the sewer to be laid in the trench, the Engineer may direct the sheeting to be drawn or redriven, or otherwise changed and altered, without compensation to the Contractor, even though such narrow trench was not caused by negligence or other fault on the part of the Contractor, his agents or employees.

Material to be used

95. Plank used for sheeting, or sheet piling and all timber used for braces, shores and stringers or waling strips shall be of pine, spruce, hemlock or other approved timber, sound, straight, free from cracks, shakes and large or loose knots, and of the required dimensions throughout.

Where in the opinion of the Engineer the material furnished by the Contractor is not of the proper quality or sufficient size or not properly placed to insure the safety of the work or of adjacent structures or property, the Contractor shall, upon notice from the Engineer to that effect, forthwith procure, furnish and set in place or drive other and satisfactory material, or place the material in a satisfactory manner; and if he shall fail or neglect to do so, the Engineer may order all or any part of the work to be stopped until such directions are complied with and the material so placed; and the Contractor shall not be entitled to claim demand or receive any compensation for larger size or better quality or different disposition of material ordered by the Engineer nor any compensation or allowance of any kind whatsoever for or on account of any damage or delay resulting from such stoppage of work.

Failure to use shoring Contractor's risk

96. The neglect, failure or refusal of the Engineer to order the use of sheeting or sheet-piling, or of a better quality or larger sizes of timber, or to order sheeting, sheet-piling, bracing, shores, etc., to be left in place, or the giving or failing to give of any order or directions as to the manner or methods

of driving or placing sheeting, sheet-piling, bracing, shores, etc., shall not in any way or to any extent relieve the Contractor of any or all of his obligations under this contract.

Removal of shoring

97. Timbering, or sheet-piling, shall be withdrawn and removed as the trenches are being back-filled, except when, by permission of the Engineer, the Contractor is permitted to leave the same in place, at the Contractor's cost.

The sheeting and bracing shall be removed in such manner as to prevent the caving-in of the sides of the cuts. While the sheeting planks are being withdrawn the vacancies left by them shall be carefully filled by ramming with tools specially adapted to the purpose, by watering or otherwise.

All plank sheeting extending below the crown of the arch on a brick sewer must be pulled until the bottoms of the planks are as high as the crown, before a depth of more than six (6) inches of earth is placed upon the arch.

The Contractor shall cut off any sheeting or sheet-piling left in place whenever and at such points as the Engineer shall order, and shall remove from the work the portion cut off, but he shall not be entitled to any compensation for cutting off and removal.

Measurement

98. No payment will be made for piles sheeting, sheet-piling, braces, shores and stringers or waling-strips unless the same are left in place by written order of the Engineer and then only for the length and amount of timber actually left in the ground, except that when the length of piles sheeting or sheet-piling cut off is less than four (4) feet the Contractor will be paid for the entire length driven, the same as if it had been left in the ground

Payment will be made for ordinary sheeting, and for all braces, shores and stringers or waling-strips, and for all sheet-piling, left in place by written order of the Engineer at the municipal rate mentioned in the Schedule of Measurement for the length and amount actually left in place, subject to the next preceding paragraph.

BOTTOM OF TRENCH AND FOUNDATIONS

99. When the nature of the ground will permit, the trench shall be trimmed for the reception of the invert to the exact depth, form and size required, and the Contractor shall shape the bottom of the ditch approximately to fit the lowest one-third of the outside circumference of the tile, taking pains to secure an extra firm bearing near the outer edges bearing area and in no case shall the bottom of the trench be shaped to fit less than one-sixth the outside circumference of the tile. In case of any unrequired variation the space is to be refilled entirely to the satisfaction of the Engineer, and at the Contractor's expense.

For pipe sewers the bottom of the trench under each bell shall be so hollowed out as to allow the body of the pipe to have a bearing throughout on the trench bottom and conveniently permit of making the joint.

When the excavation is in hard pan or rock, the Contractor will be required, if necessary, to construct a bed of coarse sand, granular

earth or gravel, three inches in depth at the bottom of the trench to receive the pipe; and the sides of the pipe shall be protected with the same material to a thickness of three inches on each side.

Soft foundations

100. Wherever the material at the bottom of the trench, when excavated to the depth required upon the contract plans, is found too soft or otherwise unsatisfactory for supporting the sewer or other structure, the Contractor shall excavate to the depth or depths required by the Engineer. Such excavation shall be classed as extra excavation and the Contractor shall receive compensation for the same. When in the opinion of the Engineer, the bottom of the trench has been rendered unfit for the construction of the sewer by the Contractor, he shall make the same good and to the satisfaction of the Engineer.

Special foundations

101. When ordered by the Engineer or required on the contract plans the Contractor shall construct a general foundation of timber or place concrete in the trench and around the sewer. This work shall be done in accordance with the contract plans or as ordered by the Engineer and shall be further done in accordance with the specifications for this class of work.

Timber platforms

102. The Contractor shall furnish all materials, tools and labour, excavate for and construct timber platforms and place timber in other special foundations for sewers, catch basins or other structures in accordance with the contract plans or as ordered in the field by the Engineer, and as herein specified.

Cedar, white pine, hemlock or other approved timber shall be furnished; all timber shall be sound, straight, free from cracks or shakes or large loose knots and squared to the dimensions required throughout its entire length. Sills or caps when used shall be firmly bolted together and to the piles upon which they may be placed, all as required and directed or shown on the plans.

When, in the opinion of the Engineer, it is necessary to lay a timber platform for foundations, the planks used shall be of the kind and quality herein described, and cut and laid in the manner designated. They shall be firmly spiked, nailed or bolted to the sills in the manner and to the extent required by the Engineer.

Measurement and compensation

103. The quantity of timber, in the platform or other foundations, shall be measured for payment on the basis of, the quantity, per thousand feet board measure (M. feet B.M.), required by the contract drawings and specifications, or as modified by orders of the Engineer. The Contractor's bid for timber in platforms, and in other special foundations, as above provided, shall include, furnishing all materials, tools and labour, completing the work, in accordance with these specifications and the contract plans, and shall include making all necessary excavation below the regular sub-grade of the sewer and doing all work incidental to, or necessary to complete, the construction of the timber platforms herein provided for.

Standard platform

104. Unless otherwise required on the contract plans, all timber platforms in foundation for vitrified clay pipe sewers shall be constructed as follows:

Sills shall be laid transversely in the trench and planking securely spiked thereto. The dimensions and the spacing of the timbers and planking to be used will be given in the field and the Contractor shall drive four-inch by four-inch (4″ x 4″) timbers by hand into the bottom of the excavation to a satisfactory bearing and shall spike the sills to the same. The price bid per thousand feet Board Measure (M. ft. B.M.) for timber platforms shall include furnishing and driving each hand pile.

Standard platform 2 ft. 6 in. will be built by bedding parallel longitudinal sleepers ...... inch by ...... inch planks into the bottom of the trench. In bedding said sleepers care must be used not to excavate material from between sleepers, nor to a greater depth than required by the grade given by the Engineer.

Said lines of sleepers shall in no case exceed a distance from each other of four (4) feet measured from centre to centre. The outer line of sleepers on either side of the sewer shall be laid with the outer edge of the plank parallel with and immediately under the outer toe of the masonry foundation to be built thereon. Said lines of sleepers shall be laid continuously throughout such length of sewer as ordered by the Engineer. Upon these lines of sleepers two-inch planks will be laid transversely in the axis of the sewer. Said planks shall not be less than eight inches nor more than sixteen inches in width and shall be laid so as to form a high flooring over the entire bottom surface of the excavation as specified, and shall be securely spiked to each sleeper with six-inch wrought iron or steel wire spikes.

The upper face of said platform or flooring as completed shall form substantially a flat surface, horizontal transversely, and shall have the same inclination longitudinally as the sewer.

When extra lumber (not shown on the plans) is ordered to be used in foundation, payment will be made for such extra amount required at the municipal rates mentioned in the Schedule of Measurement.

The Engineer reserves the right to direct the Contractor to use a different amount of timber or different width or design of foundation from that shown in the plans and payment will be made for the actual difference between the amount specified or shown and the amount corresponding to such different design. No payment will be made for a greater amount of timber than that required by the plans if the same is made necessary by any default or negligence on the part of the Contractor.

Change of foundation

105. Should, in the opinion of the Engineer, the use of a wooden invert shown on the plans, not be necessary or desirable, the Contractor shall refrain from using same at such points as said Engineer may direct.

LAYING OF VITRIFIED CLAY OR CEMENT SEWER PIPE

106. The Contractor shall at his expense furnish all the materials, tools and labour and shall construct cross frames or horses at such intervals as the Engineer may order in the field. The Contractor shall further furnish all other implements necessary to determine the proper settling of the pipes.

Pipes to be fitted dry on bank

107. All pipes, previous to their being lowered in the trench, shall be fitted together dry on the surface and matched, so that when joined in the trench they may form a true and smooth line of tubes; and in no case shall they be lowered into the trench until the same is done.

108. When the trench is properly prepared and before laying the sewer, the Contractor shall notify the Engineer who will thereupon direct an assistant (the inspector) to be present when the pipes are to be laid; and it is further expressly understood that at no other time will such laying be proceeded with.

Mortar

109. Mortar for joints shall be mixed in the proportion of one part of cement and two and one-half parts of sand.

The interior of the bell shall be wiped smooth and clean, and the hub and spigot thoroughly wet, and the annular space shall be free from dirt, stones and water.

Joints, how made, vitrified clay pipe

110. The mortar shall be laid in the collar in such manner that after the spigot end is driven into the collar the mortar will fill the annular space between the spigot and the limbs. Mortar is then to be wiped around the inside of the joint to fill any vacancies which may be left.

Special care must be taken to properly fill with mortar the annular space at the bottom and sides as well as at the top of the joints. After such space has been filled, the cement having been compacted with a wooden or iron calking tool, a neat finish shall be given to the joints by the further application of a similar mortar to the face of the hub so as to form a continuous and even bevelled surface from the exterior of said hub to the exterior of the spigot all around. All water must be kept out of the bell-hole during the laying, or else such bell-hole must be completely filled with cement mortar or with concrete (for which mortar or concrete no extra compensation will be allowed). The interior of the joint shall be wiped clean of cement by a wad made of a sack filled with hay, large enough to tightly fill the pipe and attached to a rod or cord, which shall at all times be kept in the sewer and pulled ahead past each joint as soon as cemented.

For combined sewers the annular space between the bowl and the spigot that fits into it shall be well filled all around with mortar in the usual manner, care being taken to make the entire joint perfectly watertight. Should the pipe be laid in a wet stratum, a hemp gasket reaching entirely around the pipe shall be pushed into the bell, before

the mortar is used, and thoroughly compacted with a wooden or iron calking tool, and a neat finish given to the joint by applying the mortar to the face of the bowl in such a manner as to form a continuous and even bevelled surface from the exterior of the spigot. An alternative and perhaps preferable method is to use the mortar first and complete the joint with the hemp gasket well compacted with a wooden or iron calking tool.

In laying sanitary sewers all joints shall be made with a narrow gasket of hemp or jute, and cement mortar, and special care shall be taken to secure tight joints. The gasket shall be soaked in Portland cement mortar, one of cement to one of sand (the shrinkage of cement grout makes it undesirable) and then carefully inserted between the bell and the spigot and well calked with suitable hardwood or iron calking tools. It shall be in one continuous piece for each joint and of such thickness as to bring the invert of the two pipes smooth and even. No joint shall be cemented until the gasket of the next two joints in advance are properly inserted. The remainder of the joints shall be filled with cement mortar applied by hand and a thin gasket as above inserted, well pressed into the annular space and well calked by a suitable hardwood calking tool; the joints shall then be finished by hand and levelled off from the outer edges of the bell to an angle of 45 degrees.

Joints exposed to direct sunlight shall be kept wet or suitably protected until the back filling is carried forward.

Joints for .... cement concrete pipe shall be made in the following manner ....
....
....
....

Bowl holes to be filled

111. As soon as the cementing of any joint has been completed the bowl holes under the bowl shall be carefully and compactly filled with sand, loam or fine earth.

Interior of pipe to be kept clean

112. The interior of the pipe shall be carefully freed from all dirt, cement and superfluous material of every description as the work proceeds, for which purpose a disc mould or plate attached to a rod sufficiently long to pass two joints from the end of the pipe last laid shall be continuously worked through.

The mouth of the pipe shall be carefully protected from all blasts, and the excavation shall in all cases be fully completed at least twenty feet in advance of the laying of the pipe. In all cases the mouth of the pipe shall be provided with a board, or other stopper, carefully fitted to the pipe, to prevent all earth and other substances from washing into it. In no case shall brick or stone be used for that purpose.

Connections with existing sewers

113. When sewers laid under this contract are to be connected with existing vitrified clay sewers the connections shall be made in the following manner:—

A length of at least six feet (6′) of the existing sewer shall be opened up to the surface of the ground with a width of trench equal to that specified for that size of pipe. At least two lengths of the existing sewer pipe shall be removed, the new branch or special inserted, and the connection completed by inserting a length of pipe cut to fit the closure. The pipes may be fitted together by raising the pipe in the trench a sufficient distance to permit of slipping the joints.

All branch pipe, connections and pipe of whatsoever kind shall be excavated for, fitted and laid as above described, except that house connection drains will not be laid in concrete.

Branch pipes and house connection drains when not immediately used shall be closed with an earthenware cover fitting within the bowl. The joint between the cover and the bowl shall be filled with oakum and cement mortar 1:6* and the entire surface of the earthenware cover plastered with cement mortar 1:6. The house connection drains, when required, are to be extended to a point two feet inside the curbs, or to such distance and on such grade as the Engineer shall direct.

Slants

114. The location of the slant end of each lateral or Y branch is to be at the point shown on the plan; when placed otherwise it shall be defined in such manner that it can be found by measurement from the nearest manhole.

Reducers to be used

115. Connection with a 6-inch pipe into a 9-inch junction must be made with a reducer. Extra work of any kind required will be paid for at the municipal rate as shown in the Schedule of Measurement.

Freezing weather

116. If pipe sewers and drains are laid at any time when the temperature of the air is below thirty-two (32) degrees Fahrenheit, the Contractor shall at his own cost and expense take all such precautions as the Engineer may direct, by heating the water or heating the ingredients of mortar or otherwise, to prevent injury or damage to the work, and no pipe shall be laid at any time when the temperature of the air is below 25° F., unless permission of the Engineer is first obtained in writing.

No walking on pipe

117. No walking on or working over the pipe after it is laid (except as may be necessary in tamping the earth and refilling) will be allowed until there is at least 20 inches of earth over the same.

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*Lean mortar to permit of removal without damage to bowl.

RE-FILLING AND FILLING

118. After the sewer with its required foundation is laid or built, the work shall be protected and the filling carefully packed and rammed under and around the sewer by trusty persons with proper tools. The refilling of the trenches to a height of at least (2) two feet above the top of sewer shall be done in layers not exceeding six inches thick in the loose, and the earth used is not to be dumped in, but is to be placed and spread evenly with shovels at that thickness, then satisfactorily compressed by iron tampers. No retaining walls for the refilling will be allowed in the trenches over the sewers, whether for temporary use or otherwise.

Refilling

119. No filling to the height specified above shall be thrown in from the top of the trench or dumped from buckets but shall be dumped or thrown in upon a section already brought above said specified height. The trench shall then be refilled to the required height in layers, each layer not to exceed one foot in thickness. The earth or sand shall be properly rammed as directed or permitted by the Engineer as the work progresses. Care shall be taken to carry the fill up evenly on opposite sides of the sewer.

Manner of placing materials

In no case shall back-filling be placed around or over vitrified clay sewer pipe until twenty-four hours have elapsed after the placing of the mortar in the joints.

120. The refilling in all cases shall be of good, clean earth, sand or gravel free from stones above eight inches in diameter, and not containing, in any part or place, a proportion of stones below that size not exceeding one part of stone to three parts of earth. For height of at least 1½ feet above the top of all pipe sewers the material shall be entirely free from stones.

Kind of earth to be used

No house ashes, putrescible refuse or other material of an unsatisfactory character shall be used in refilling, and the Contractor shall not permit the trench to be used as dumping for refuse.

The use of frozen earth in refilling shall not be allowed unless permitted by the Engineer in writing and then only to the extent expressly specified.

Deficiency of material

121. Should there be a deficiency of proper material for refilling, the Contractor will be required to furnish the same at his own cost and charge.

122. The space between the lines of excavation in tunnel and the outer surface of the masonry shall be completely backfilled with selected excavated material solidly packed and thoroughly rammed and consolidated in place.

Backfilling in tunnel

Backfilling in shafts and manholes

123. The filling of all shafts and around manholes shall be done with suitable material approved by the Engineer which must be carefully lowered and thoroughly compacted by ramming.

Removal of surplus

124. As the trenches, shafts or manholes, as the case may be, are filled in and the work progresses the Contractor shall cart away or remove all surplus earth, stone and other material from the ground, to such places on the line of the work as directed, and leave all roads, places and public or private lands free, clear and in good order and on the completion of each section of 100 feet of sewer, the regrading and repaving over the same shall be done and completed. In case this is neglected, the Contractor will be allowed only twenty-four hours to remove the surplus, or repave the trench, after a written notification of his failure or neglect, said notice to be served on the Contractor, either personally or by leaving it at his residence, or place of business or with his agent in charge of the work; when, if not done, it will be done by the municipality who may at its discretion sub-let all such uncompleted work, the same to be done entirely at the Contractor's cost and expense.

The following places ....
....
....
....
have been set aside to serve as dumping grounds for surplus material under this section of the contract.

Bulkheads, curves, etc., to be located

125. All bulkheads and points of beginning and ending of all curves, connections, house connections and culverts shall not be covered over nor filled around until the same shall have been located and measured by the Engineer and permission given by him to refill the trenches at such points.

TEMPORARY REPAVING

126. When the back filling of the trench is completed the Contractor shall temporarily repave or resurface the openings in the pavements in such a manner as to make the surface of the roadway accessible for foot and vehicle traffic, in a manner satisfactory to the Engineer and shall maintain the same until the permanent repaving is placed. The compensation for temporary repaving or resurfacing shall be included in the bid.

Temporary repaving to approximate original pavement

No mounding up of the material over the trench and covering the same with riffraff or loose stones will be considered as a compliance with the above requirements, but the temporary repavement shall be of a character approximating the character of the original pavement. The Contractor shall at his own cost and expense, immediately remove and replace in a satisfactory manner any and all such repavement as shall be condemned by the Engineer as being unsatisfactory; and in case the Contractor shall refuse, neglect or fail to remove and replace such unsatisfactory pavement, or to make satisfactory progress in doing so within twenty-four (24) hours after the receipt of a written notice so to do from the Engineer, then the Engineer may proceed to remove and replace such condemned repavement, and all the cost and expense thereof, including the cost of any new material that may be required, shall be charged to the Contractor, and may be retained by the Corpora-

tion out of any moneys due or to become due to the Contractor under this contract. Broken cement sidewalk material and concrete base of roadways may be used by the Contractor without charge for temporary repaving.

PERMANENT REPAVING

Corporation responsible for permanent repaving

127*a*. "*The permanent and final repaving of the roadway or carriageway and the reconstruction of all permanent gutters, curbs and gullies within the limits of the trench as specified shall be done by the Corporation and will be without cost or expense to the Contractor, and said Contractor will be in no way liable or responsible for the condition of the roadway after the Corporation assumes the maintenance; except that, should any defect in said permanent pavement become manifest as a result of a broken pipe, open joint, or other defect in the sewer or any of its appurtenances or connections then the said Contractor shall be liable and responsible for all expenses and damages arising from such defects, and shall reimburse the Corporation for any and all costs and expense to which it may be put by or because of such defects or the results arising therefrom, and the Engineer shall be the sole judge in determining the extent and damage arising from such defect.*

Contractor responsible for permanent repaving

127. Six months after completion of the laying of the sewer and pavement the Contractor shall, unless otherwise specified and agreed upon, permanently repave all openings in street pavements made for the execution of work under this contract, and shall further permanently repave all pavements damaged in any manner by the work under this contract. All such repaving shall be maintained for a period of six months after the final acceptance of the work as provided in section.... of this contract. The character of the existing pavement is shown upon the contract plan and the pavement shall be repaved with the same kind of material.

Restoration of maintenance contract pavement

128. Whenever it becomes necessary for the Contractor to restore asphalt, wood-block, brick or other maintenance contract pavement, the order for such restoration shall be given to the company or individual who has a contract with the Corporation for the maintenance of that particular pavement, and should the Contractor neglect or refuse to send such order to the proper company for the restoration of so much of the pavement as shall be required by the Engineer, then the Corporation may proceed to have the work performed by said company or individual, and the expense thereof charged to any sum or sums retained by the city for and on account of this contract.

VITRIFIED CLAY SEWER PIPE

Quality

129. All standard sewer pipe and specials shall, unless otherwise specified, be of the best quality of vitrified clay salt glazed sewer pipe, of the bowl and spigot pattern, and shall be true to form and size.

130a. Vitrified clay sewer pipe shall be of the following dimensions:

Diameter.	Thickness.	Depth of Socket.	Annular Space.
6 inch....................	⅝ inch.	2 inch.	½ inch.
8 "	¾ "	2½ "	½ "
9 "	⅞ "	2½ "	½ "
10 "	⅞ "	2½ "	½ "
12 "	1 "	3 "	½ "
15 "	1¼ "	3 "	¾ "
18 "	1½ "	3 "	¾ "
20 "	1⅔ "	3½ "	¾ "
24 "	2 "	3½ "	1 "
30 "	2½ "	4½ "	1 "

130. Vitrified clay sewer pipe shall be of the following dimensions:

D Internal Circular Diameter.	L Laying Length.	H Diameter inside of Hub.	S Depth of Hub.	B Taper of Hub.	T Minimum thickness of Shell.
in.	ft.	in.	in.		in.
6	2	8¼	2	1 : 20	⅝
8	2, 2½, 3	10¾	2½	1 : 20	¾
10	2, 2½, 3	13	2½	1 : 20	⅞
12	2, 2½, 3	15¼	3	1 : 20	1
15	2, 2½, 3	18¾	3	1 : 20	1¼
18	2, 2½, 3	22¼	3	1 : 20	1½
21	2, 2½, 3	26	3½	1 : 20	1¾
24	2, 2½, 3	29½	3½	1 : 20	2
27	3	33¼	4	1 : 20	2¼
30	3	37	4½	1 : 20	2½
33	3	40¼	5	1 : 20	2⅝
36	3	44	5	1 : 20	2¾
39	3	47¼	5	1 : 20	2⅞
42	3	51	5	1 : 20	3

NOTE: When pipes are furnished having an increase in thickness over the dimensions given in column T, then the diameter of the hub H shall be increased by an amount equal to twice the increase of thickness of shell.

131. Curved pipes, bends, slants and branches are to be equal in all essential respects to the straight pipes of the same diameter.

132. All pipes and specials shall be well vitrified, free from blisters, laminations, lime spots, and free from cracks and checks extending into the body of the tile in such a manner as to appreciably decrease the strength.

133. All pipes and specials when struck with a light hammer, shall emit a clear high pitched ring. On fracture the absorption shall not exceed five per cent.

134. Pipe designated straight shall not vary from a straight line more than one eighth inch per feet of length.

135. Curves shall be at angles of 45, 22½, 11¼ degrees, etc., as required. They shall substantially conform to the curvature specified.

136. The ends of pipe and specials shall be square with their longitudinal axis or tangent.

Test for absorption

137. The specimens shall be sound pieces, with all edges broken, from pipes broken in the crushing or other tests. They shall be from 12 to 20 square inches in area, and shall be as nearly square as can be readily prepared. They shall be free from observable cracks, fissures, lamination or shattered edges.

Preparatory to the absorption test, the specimen shall be first weighed and then dried in a drier or oven at a temperature of not less than 110 degrees C. (230 degrees F.) for not less than three hours. After removal from the drier the specimen shall be allowed to cool to a temperature of 20 to 25 degrees C. (68 to 77 degrees F.), and then reweighed.

If the specimen was comparatively dry when taken, and the second weight closely agrees with the first, it shall be considered dry. If the specimen was known to be wet when taken it shall be placed in the drier for a further drying treatment of two hours, and reweighed. If the third weight checks the second the specimen shall be considered dry. In case of any doubt, the specimen shall be redried for two hour periods, until check weights are obtained.

The balance used shall be sensitive to 0.5 g. when loaded with 1 kg., and weighings shall be read to the nearest gram. When other than metric weights are used, the same degree of accuracy shall be obtained.

The specimen after final drying, cooling and weighing, shall be placed with other similar specimens in a suitable wire receptacle, packed tightly enough to prevent jostling, covered with distilled water or rain water, raised to the boiling point and boiled for five hours, and then cooled in water to a final temperature of 10 to 15 degrees C. (50 to 59 degrees F.).

The specimen shall be allowed to drain for one minute, the superficial moisture removed by towel or blotting paper, and then placed upon the balance.

The test result shall be calculated as percentage of the initial dry weight.

Pipe subject to inspection

138. All sewer pipes shall be subject to inspection at the factory, trench or other point of delivery by a competent inspector employed by the purchaser or consumer. The purposes of the inspection shall be to cull and reject pipes which, independent of the physical tests herein specified, fail to comply with the requirements of these specifications.

Sewer pipes shall be subject to rejection on account of the following:

(*a*) Fracture or cracks passing through the shell or hub, except that a single crack at either end of the pipe nor exceeding two inches in

length or a single fracture in the hub not exceeding three inches in width or two inches in length will not be deemed cause for rejections unless these defects exist in more than five per cent. of the entire shipment or delivery.

(*b*) Blisters where the glazing is broken or which exceed three inches in any diameter, or which project more than 1/8 inches above the surface.

(*c*) Laminations which indicate large voids in the pipe material.

(*d*) Fire cracks or hair cracks sufficient to adversely effect the strength, durability or serviceability of the pipe.

(*e*) Failure to give a clear ringing sound when placed on end and dry-tapped with a light hammer.

(*f*) The presence of any considerable number of lime spots.

(*g*) The presence of any holes due to presence of vegetable matter in unburnt clay.

All rejected sewer pipes shall be plainly marked by the inspector and shall be replaced by the manufacturer or seller with pipes which meet the requirements of these specifications without additional cost to the purchaser or consumer.

MATERIALS

Materials must be of the best kind

139. All the materials and all the work done in the carrying out of this contract must be up to the standard prescribed in these specifications, and where such material or work is not definitely described, it must be of the best of its kind, and in every case meet the requirements of the Engineer. All materials not filling these requirements must be immediately removed from the ground. Wherever an article or any class of materials is specified by a trade name or by the name of any particular patentee, manufacturer or dealer, or by reference to the catalogue of any such manufacturer or dealer, it shall be taken as intending to mean and specify the article or materials described, or any other equal thereto in quality, finish and durability, and equally as serviceable for the purposes for which it is or they are intended.

Samples

140. The Contractor shall submit samples, for the approval of the Engineer, of all material so required, and no material shall be used which is in any way inferior to the approved sample; such approval shall not be considered as any waiver of objection to the work at any subsequent period on account of unsoundness or imperfection of materials used, or on any other account provided in this agreement: and in order to afford the Engineer ample opportunity for inspection, all material shall be at the location of the work at least three days before it is used except as provided for in this agreement.

BRICKS

Quality ordinary sewer bricks

141. Sewer bricks shall be either wire cut shale bricks or other approved bricks, whole, new and of the best quality of uniform size with straight and parallel edges and square corners; they shall be of compact texture, burned hard and entirely through, free from injurious cracks and flaws, tough and strong, and shall have a clear ring when struck together. The sides, ends and faces of all bricks shall be plane surfaces at right angles and parallel to each other. Bricks of any make shall not vary more than one-sixteenth (1-16) of an inch in thickness, nor more than one-eighth of an inch in width or length from the following dimensions.........
....

The truest bricks shall be used in the face of the masonry and the exposed surfaces shall be true and smooth planes.

These bricks shall be capable of passing the following absorption test: Upon immersion in water for six hours the increase in weight must not exceed six (6) per cent.

Vitrified bricks and blocks

142. Whenever vitrified bricks shall be required in the sewer or if blocks are substituted, they shall comply with the following specification for vitrified bricks or blocks:

The bricks must not be less than ....
or if blocks are substituted they shall not be less than ....
................, and must be even, regular and uniform in size and shape and shall not vary more than 3-16 inch in size, and they shall be nearly as possible alike in colour and appearance throughout. The sides and ends must be at right angles to one another, and must be straight and even. The bricks and blocks throughout must be free from cracks, checks or any imperfections which, in the opinion of the Engineer, may unfit them for use in the work; they must also be hard, tough, uniform in texture and thoroughly annealed throughout.

The bricks and blocks must be capable of standing the following tests:

Absorption test

A piece broken from the centre of any brick or block not more than ¾ inch in thickness and from 60 to 120 grammes in weight, is to be thoroughly dried and then immersed in water; after being in water for six hours, the increase in weight of any brick or block must not exceed two and one-half per cent.

Abrasion test

Any vitrified bricks must not lose more than 22 per cent. of their weight after 1,000 nor more than 34 per cent. after 2,000 revolutions when tumbled in an iron rattler, revolving at the rate of 26 to 30 revolutions per minute, which rattler contains 100 cast iron cubes (with corners rounded to about ¼-inch radius) weighing two pounds each, and 10 cast iron bars 2 in. x 2 in. x 8 in. (with corners rounded to about ¼-inch radius) weighing about 8 pounds each. The rattler shall be 24 inches in diameter by 36 inches in length, with four iron bolts, each ¾-inch in diameter, projecting 1½ inches on the inside surface of the rattler. These bolts are to be placed in the two opposite staves (two in each) staggered in such a manner as to prevent the cubes from sliding instead of tumbling.

Any five vitrified blocks must not loose more than 16 per cent. of their weight after 1,000 revolutions nor more than 22 per cent. of their weight after 2,000 revolutions, when tested in the same manner as just prescribed for vitrified brick.

Samples to be submitted

143. The Contractor shall furnish the Engineer with at least seven (7) samples of the brick which he proposes to use on the work, at least one (1) week before the delivery of any bricks on the ground. These samples shall be subjected to such tests as the Engineer shall determine, at least one (1) brick being retained in the office of the Engineer.

Tests

144. The tests shall be made of samples of brick selected at random from time to time from the Contractor's supply in cars or on the works. Should the samples thus tested fail to come up to the standard prescribed herein, the whole lot may, at the discretion of the Engineer, be condemned.

Culls

145. All bricks delivered for use shall be culled by the Contractor when required. No bricks thrown out in the culling shall be used in any work done under any contract for sewers, except that the best of the culls may be used in manholes, above the level of the top of the sewer, if permitted by the Engineer.

All broken bricks or bats not required in the work must be immediately carted off the ground at the expense of the Contractor.

CEMENT

Quality and packing

145a. All cement used in the work shall be of some known and approved brand of Portland cement. It shall be packed in strong canvas sacks or barrels of uniform size.

Storage

146. The Contractor shall store his cement in a tight building, on a dry floor placed above the surface of the ground and shall notify the Engineer of each delivery of cement.

Cement shall be kept in stock sufficient for four weeks' use. Each carload lot shall be kept separate.

After each lot has been tested in the manner prescribed and proven satisfactory a certificate of acceptance of such lot will be given the Contractor, who may then, and not until then, remove the cement thus released to be used in the work, and the Contractor shall use no cement in the construction of the work other than that which has been so released.

Tests

147. All cement shall be tested by Messrs. .... of .... in the manner adopted by and shall pass the test specified by the Canadian Society of Civil Engineers with such revisions as may be made from time to time. In event of any disagreement as to quality of cement it is hereby agreed that the result of a second and third test by .... made in the manner prescribed shall be final and conclusive.

Cement to be protected from the weather

148. When cement is delivered on the work it must be protected at once from the weather and kept dry, and in no case will it be allowed to be placed upon the ground without blocking under the barrels.

Cement may be rejected after acceptance

149. The Engineer may, at any time, suspend or prohibit the use of any brand of cement that develops objectionable qualities after the acceptance thereof.

SAND

Quality and grade

150. All sand shall be live, clean, sharp, coarse, natural or crushed silicious material, substantially free from loam or other foreign matter.

151. Sand used for concrete shall be uniformly graded from coarse to fine, no particles being more than one-eighth (1/8) of an inch in diameter and containing not more than ten (10) per cent. very fine. If used for reinforced concrete it shall not contain more than one (1) per cent. clay, and if used for plain concrete it shall not contain more than 4 per cent. clay on analyses. The material must be screened or washed whenever, in the judgment of the Engineer, this becomes necessary to meet these requirements.

152. Sand used for mortar for brickwork shall be of suitable size and quality.

BALLAST

Quality and size

153. Ballast for "Classes A, B, C, D, and F" concrete shall consist of clean broken stone of granite diorite, igneous trap sandstone or limestone of approved hardness and toughness, shall be free from all impurities and dust and be uniformly graded from one-eighth (1/8) inch diameter up to the maximum size specified for the different classes of concrete.

154. Ballast for "Class A," "Class D" and "Class F," concrete, shall be of such size that no particle shall exceed one (1) inch in its greatest diameter.

155. Ballast for "Class B" and "Class C" shall be of such sizes that no particle shall exceed two (2) inches in its greatest diameter.

156. Ballast for "Class E" concrete shall be of such sizes that no particle shall exceed three-eighths of an inch in its greatest diameter: "Class E" concrete is shown as facing mixture on the plans.

157. Screened gravel approved by the Engineer may be substituted for crushed stone as specified in Class B, C, and F ballast.

158. The total amount of clay in the sand and ballast together shall not exceed that specified for sand alone. The Engineer shall reject all material not complying with these requirements and the same shall be removed within 48 hours from the work at the Contractor's sole cost.

CEMENT MORTAR

159. All cement mortar is to be composed of one part approved cement and two and one-half parts sand. It is to be carefully and thoroughly mixed dry, until the entire mixture of cement and sand is of one uniform colour; then a sufficient quantity of water is to be added to make it of good consistency.

160. The mortar is to be mixed in no greater quantity than is required for the work in hand. Any excess that may be left over at night, or that may have been standing long enough to set, is not to be re-tempered, nor used in any way except for backfilling trenches.

Measure to be approved by the Engineer

161. Both cement and sand are to be, in all cases, measured in the proportions above required; cement shall be measured as in the original package, the sand shall be measured loose.

All mortar must be mixed in a proper box, made for the purpose and in no case upon the pavement or ground. (See instructions for concrete masonry.)

162. When necessary, in the opinion of the Engineer, cement alone, without any admixture of sand, will be used.

WATER

163. All water used in the construction, whether for moistening the brick or for making mortar and concrete and keeping the same wet, must be ordinary clean water. Water contaminated with sewage, oily water or water containing dirt, clay, lime, filth, or vegetable matter must not be used.

MIXING AND PLACING CONCRETE MASONRY

Location

164. The Contractor shall furnish and place all concrete structures shown on the drawings, or specified herein, and shall build any additional structures, and shall place any other concrete which may be found necessary to complete the work.

Joints

165. Joints between different sections of concrete masonry shall be made in such a manner and by such methods as the Engineer shall direct, and the location of such joints shall be subject to his approval.

Bonding

166. The Contractor shall make provision for bonding between sections of concrete masonry laid at different times, in a manner satisfactory to the Engineer.

Pipes laid in concrete

167. Concrete cradles for pipe shall be put in place as directed in one operation up to the correct subgrade for laying the pipe, which shall then be laid thereon before the concrete has set and the remainder of the concrete cradle shall then be immediately put in place.

All pipes are to be laid true in line and grade throughout, according to the lines and grades furnished from time to time. The ends of the pipes shall abut against each other in such manner that after the sewer is completed there shall be no shoulder or unevenness of any kind along the bottom half of the sewer on the inside and each pipe shall be laid on an even, firm bed so that no uneven strain will come on any pipe and particular care shall be exercised to prevent bowl and spigot pipes bearing on the sockets.

Proportions

168. Concrete, except where otherwise expressly ordered, shall be composed of a mixture of cement, sand, and ballast mixed with a sufficient quantity of water, and the ingredients shall be usually mixed in the following proportions by volume:

——	Cement.	Sand.	Ballast.
Class A	1	2	4
Class B	1	3	5
Class C	1	3	7
Class D	1	4	9
Class E (Facing Mixture)	1	1	3
Class F	1	3	7

Concrete masonry

169. The foundations shall be trimmed as accurately as practicable and shall be at least as large as the dimensions on the approved drawings. Form work shall be erected wherever foreign material can become mixed and interfere with the concrete or mortar while the same is being deposited.

The bearing stratum shall be cleaned of all foreign material. It shall also be free from water if practicable. Under no circumstances shall mortar or concrete be deposited in running water.

One sack of cement containing 94 pounds net shall be taken as equivalent to one cubic foot of cement. All sand, crushed stone and gravel shall be measured by loose volume.

The necessary amount of water to produce the required consistency of mortar or concrete shall be determined from time to time, taking into account the atmospheric conditions and the variations of moisture in the sand, crushed stone or gravel before mixing.

All of the materials shall be systematically measured throughout the whole of the work, and the required proportions shall be accurately maintained.

Mixing of materials

170. All mortar and concrete shall be made in batch mixers unless it is impracticable to do so, in which case it shall be mixed by hand.

Mixing by hand shall be done on a smooth water-tight platform. The sand and cement shall first be mixed dry until the whole mass is

homogeneous and of perfectly even colour throughout. Sufficient water shall then be added to make flowing mortar. In the process of making the mortar the materials shall be turned over at least five times. If concrete is to be made, wetted crushed stone or gravel shall be placed on platform, then sand, and finally cement, and the mass turned over at least four times or until it has become homogeneous and of even colour and consistency.

Mixing by machine shall produce a homogeneous mass of concrete perfectly uniform in colour and even in consistency, the whole mass being kept in continuous motion within the machine for a period of not less than one minute, and the entire batch shall be discharged before placing further materials in the machine.

The re-mixing or re-tempering of mortar or concrete which has partly set shall not be permitted.

The general consistency of the mortar or concrete shall be such that the mass will flow readily in the forms, and that it can be conveyed from the mixer to the forms without separation of the ingredients.

The temperature of the mixture on completion of the mixing shall not be less than 40 degrees F. The water, sand and crushed stone shall be heated, if necessary, to obtain the result. In no case shall crystals of ice either in the sand or in the crushed stone be permitted to reach the mixing platform or the mixing machine.

Preparation of surface to receive concrete

171. The surface on which concrete is to be deposited shall be specially cleaned for the purpose. If the surface be rock it shall be given a coat of grout composed of equal parts of cement and sand well brushed into the surface and all the crevices. If the surface, vertical or otherwise, be of concrete which has not set hard it shall be spalled or roughened and afterwards thoroughly brushed over with grout composed of equal parts of cement and sand. If the surface be of concrete which has not set hard the spalling or roughening may be omitted; but grout composed of equal parts of cement and sand shall be applied as specified above.

In all cases laitance which may have formed on the surface of deposited concrete shall be carefully and entirely removed.

Concrete to be conveyed in water-tight receptacles

172. Concrete shall be conveyed in water-tight carriers and be deposited in such a manner that the ingredients will not be separated, and the mass shall be consolidated by being worked after placing. The coarser ingredients shall be removed from contact with the form work by the manipulation of a special tool.

Concrete to be deposited, etc.

173. Concrete shall be deposited in approximately horizontal masses, and the work shall be stopped only at regular or temporary vertical bulkheads.

During freezing weather concrete shall be taken from the mixer and be deposited in the forms so that no part of it shall be frozen, and the temperature of the mass when deposited shall not be less than 40 degrees F. The concrete shall be prevented from freezing until setting has taken place and until the process of hardening has begun.

Concrete must be placed in the forms within ten minutes of the time the water is added.

The depositing of concrete at expansion joints shall be done with the same care and attention as that required to ensure a smooth finish to exposed surfaces.

When concrete is to be deposited under water the site shall be cleaned from all foreign matter and all currents of water shall be eliminated. The concrete shall be deposited immediately after mixing in such a way as to displace the water and at the same time to obviate the separation of the ingredients. The work shall be carried on in such a manner as to prevent the formation of laitance between successive masses of concrete.

Surfaces

174. Trowelled floated horizontal surfaces shall not be less than one inch in thickness. They shall be composed of mortar or concrete proportioned according to the requirements for wear. The mortar shall contain at least one part of cement to two and one-half parts of sand. The concrete shall contain at least one part of cement to one part of sand and three parts finely crushed rock or gravel.

If possible the surfacing shall be applied immediately after the placing of the mass concrete, but, when this is impracticable the mass concrete shall be thoroughly washed and treated with a coat of grout composed of equal parts of cement and sand thoroughly brushed in before the surfacing is applied. In trowelling or floating the surface pure cement shall not be used.

Field tests of concrete

175. Tests shall be made of concrete and mortar as the work progresses to check the density of the mixtures and the rate of settling. The test pieces shall be cubes, rectangular prisms or cylinders having a volume of about one cubic foot. They shall be poured from the regular run of the mortar or concrete as deposited, and be left to set under the same conditions as the material in the structure. There shall be two such test pieces made from each day's work. The test pieces shall be carefully examined before the form work is removed.

Inspection

176. There shall be constant competent inspection throughout the whole of the work. The Contractor shall notify the Engineer in charge of the work at what times and at what places concrete is to be mixed and placed; and no such work shall be done except in the presence of the Inspector.

Curing

177. Concrete shall be protected from the direct rays of the sun for at least three days after being deposited, when the maximum temperature in the shade is above 60 degrees F. in the sun.

For a period of seven days after being deposited concrete shall be kept moistened when the maximum temperature in the shade is above 60 degrees F.

178. The forms shall not be removed from concrete work until the concrete is safely self-supporting, and where additional concrete is to be added, until it has sufficient strength to safely sustain the superimposed load.

Removal of forms

179. Should any voids or other defects be discovered in any part of the work when the forms are taken down, or at any other time, the defective work shall be removed and space refilled with suitable material in a proper manner, at the expense of the Contractor.

Defective work

CONCRETE AND BRICK SEWERS

180. When the trench is properly prepared, the foundation shall be laid, and the building of the sewer shall proceed under the supervision of a duly authorized Inspector, and at no other time shall such construction work be done. Unless otherwise ordered or permitted by the Engineer not less than fifteen feet (15′) of foundation shall be built at any time in any one length of trench or tunnel.

Inspection

181. The Contractor shall provide all forms and centres for shaping the concrete. Forms shall be water-tight, true to required lines and grades and of the required shapes and sizes. They shall be so strongly built as to withstand the ramming of the concrete, and all operations incidental to placing the concrete without being deformed or displaced. The faces of all forms against which the concrete is to be placed shall be smooth, clean and uniform and smeared with soap, oil, or other suitable substances, to prevent the adhesion of the concrete. For the construction of concrete sewers the contractor may use either wooden or steel forms. If wooden forms are used they shall be made with finished surfaces so as to give a smooth surface to the inside of the sewer. All parts of the forms shall be so made as to give a continuous surface on the inside of the sewer without projections or other irregularities. Form work shall be so fastened together that it may be removed without injury to any part of the permanent structure.

Forms and centres

The use of small rods to hold the forms will be allowed, provided the proper means be used to take out a portion of each of the rods nearest the surface, to a depth of at least two (2) inches. All holes left after the removal of the rods shall be immediately and completely filled with cement mortar and the surfaces left true and in good condition.

Forms and centres used more than once shall be subject to all the requirements specified. If re-used they shall be thoroughly cleaned and all particles of cement or other foreign matter adhering to the surfaces exposed to the concrete removed to the satisfaction of the Engineer. The use of forms that have become distorted or are otherwise considered unsatisfactory by the Engineer shall not be permitted, and if condemned by him shall be immediately removed from the work.

Forms not conforming to the specifications shall not be used and when rejected shall be immediately removed from the work.

Removal of forms or centres

182. No forms or centres shall be removed or struck without the expressed consent of the Engineer, and the removal of the forms shall be done with great care so as to avoid injury to the concrete. No forms or centres used for the construction of concrete sewers shall be struck or removed until the backfilling has been carried to a height of at least two (2) feet above the top of the arch ring except as may be expressly ordered by the Engineer. Centres shall not be struck until the concrete has sufficiently set and in no case shall they be struck until forty-eight hours have elapsed after the completion of the concreting.

In case the Contractor shall slacken any centre before the end of the above named period or contrary to the orders of the Engineer or inspector, then the masonry shall be condemned, even though there is no apparent defect.

Section of sewer

183. The sewer shall conform accurately in its sections to the plans furnished by the Engineer. All inverts and bottoms of sewers are to be shaped from the profiles or templates properly spaced and accurately set to guide the work. The profiles shall not be more than 15 (fifteen) feet apart.

All the allowance must be made by the Contractor for the shrinkage or compression of the concrete and brick masonry in order to secure the specified size and form of the sewer.

Curves

184. All curves shall be true arcs, the profiles or inverts being properly arranged and the centres being constructed so as to conform accurately to the radii of the curves.

Bricks to be wet before laying

185. The bricks are to be thoroughly wet immediately before laying. Every brick is required to be laid in a full joint with mortar made as previously described in these specifications, on its beds, ends and sides, at one operation. In no case is mortar to be slushed or grouted in afterwards. The bricks are to be neatly and truly laid, every course by line, and the joints to be carefully struck on the inside. The bonds in all cases to be formed with a row of headers every sixth course, except in arches and inverts.

The courses of the brickwork are to be kept perfectly straight in the direction of the sewer and parallel to its flow-line.

Especial care shall be taken to make the face of the brickwork smooth.

All unfinished brickwork shall be racked back in courses and in no case will it be allowed to be toothed unless by permission in writing from the Engineer. Before any new work is joined thereto, the bricks must be scraped thoroughly clean, scrubbed with a stiff brush if necessary, and well wetted.

Inverts

186. Where the invert of the sewer is shown to be built entirely in brickwork each ring of brickwork shall be laid separately for not less than four courses in advance of the ring above. In all cases the top face of the lowest ring shall be plastered with cement mortar one-half inch thick before laying the superimposed course of

brick. When the upper course is being laid additional cement mortar shall, if necessary, be used to bed each brick in the regular manner.

Brick arches

187. Immediately after laying the brickwork, the whole outer surface of the arch, above the springing line, shall be plastered to a thickness of one inch with Portland cement mortar, mixed in proportion of one part cement and two and one-half parts sand. The top of the plaster shall be neatly trowelled to a smooth surface.

Where sewer is built wholly in tunnel the plastering on the outside of the arch shall be omitted.

The inner surface of the arch shall be carefully scraped, the brickwork thoroughly cleaned, and any defective joints filled in with cement mortar. Immediately after the centres are withdrawn any defects shall be immediately corrected.

Joints in brickwork

188. All bricks shall be laid so that the joints appearing on the interior face of the sewer shall not in any case exceed one-quarter of an inch in width. All joints in the inverts shall be carefully struck while fresh and in any case not later than three days after the arch has been covered, and such as are imperfectly filled or otherwise unsatisfactory in workmanship or appearance shall be filled with cement mortar or shall be raked out to a depth of one inch and pointed, as the work progresses, if required by the Engineer.

Side junctions, slants, etc.

189. Intersections or lateral sewers, whether of brick or pipe, and all junctions for catch basin drains shall be built into the sewers at such places as are shown on plans. Six (6) inch junctions for house drains shall be built into the sewers in a thorough and workmanlike manner, commencing ten (10) feet from street corners and to be placed thence .... feet apart through the blocks, or as otherwise shown on the plans. A six (6) inch junction shall be built opposite each fire hydrant, and water pipe valve. The pipe junctions shall have socket ends and, where required by the Engineer, shall be carefully closed by cementing a tile disc or stopper in the socket.

In brick sewers all junctions shall be slants with one end cut at an angle of approximately forty-five (45) degrees with the axis of the slant and the other formed into a socket.

The length of the short side of the slant, not including the socket, shall be not less than

6 inches for one (1) ring of brick masonry.
12 inches for two (2) rings of brick masonry.
18 inches for three (3) rings of brick masonry.
24 inches for four (4) rings of brick masonry.

Concrete sewers, brick lining

190. The dish or central portion for a width of eighteen (18) inches on either side of the centre line shall be built in place concentric with and to within a distance of ($4\frac{1}{2}$) four and one-half inches of the finished surface of the invert. The form for the balance of the concrete shall be supported on the dish.

On the backing thus prepared the ($4\frac{1}{2}$) four and one-half inch ring of specified brick lining shall be laid in Portland cement mortar.

Inverts shall be grouted in and allowed to set at least twenty-four hours before the arch is turned.

REINFORCED CONCRETE

191. Reinforced concrete shall be placed at such points as shown on plans and elsewhere as may be required.

The concrete used shall be "Class A" concrete as herein specified, unless otherwise directed. It shall be laid with special care to insure the proper embedding and surrounding of the reinforcing material.

In no case shall any reinforcing material be placed so as to be less than one (1) inch from any surface.

All the requirements of the preceeding sections shall apply to reinforced concrete as far as consistent.

Reinforcing steel

192. All reinforcing material shall be open-hearth steel corresponding in quality to the requirements of the Manufacturer's Standard Specifications for Medium Steel and shall be subject to such tests and inspection as the Engineer may direct. Contractor shall supply test pieces to the Engineer whenever required without charge. Test pieces for rods shall be 16 inches long.

All material shall be free from slag, scale, or other injurious matter, and shall be stored and handled in such manner as to protect it from injury. Reinforcing material shall be so supported during construction as to insure that it will occupy its designed position in the completed structure.

Reinforcements shall be lapped at points of meeting for such a distance (not less than 8 inches or more than 18 inches) as the Engineer may determine, and shall be bound or fastened together with number 14 gauge wire in an approved manner.

No material shall be permitted to adhere to the surface of the steel reinforcing until the concrete in which it is to be embedded is being deposited.

Cleaning of form work

193. Immediately before depositing the concrete the form work shall be entirely cleaned of all foreign material, preferably by the use of a pressure hose and nozzle discharging water, steam or air.

Depositing of concrete

194. The concrete shall be deposited in small quantities, preferably as a uniform stream. It shall be manipulated in such a manner as to insure perfect adhesion to the entire surface of the steel reinforcing and to remove impounded water or air.

The concrete for slabs shall be deposited continuously with the beams. Special care shall be exercised to procure perfect homogeneity of tee-beam construction.

Discontinuance of work

195. Every structural element shall be completed without discontinuance if practicable. Unless completed in one operation, beams and slabs shall be discontinued only by use of vertical bulkheads placed at the section of maximum bending moment.

Freezing weather

196. In protecting reinforced concrete from frost a system which will drive the moisture out of the concrete shall not be used.

197. The forms shall not be removed until the times named in the following table have elapsed after depositing concrete, not counting periods in which the temperature has been below 35 degrees F.

Nature of work.	Time in days.

RUBBLE CONCRETE

Soundness of boulders and pieces of rock

198. All boulders and pieces of rock shall be perfectly sound, impervious and durable.

Embedding rubble

199. All boulders and pieces of rock shall be thoroughly cleaned of foreign material, and after being wetted they shall be either floated into the concrete matrix or placed upon a floating bed with full bearing, in which case the concrete, as it is being raised around them, shall be manipulated in a manner similar to that required for exposed faces of walls. The mortar in the concrete shall be made to adhere perfectly to every part of the surface of the boulders and rock.

STONE MASONRY

Quality of stone

200. All stone must be good, sound, hard, quarried............ .... stone, as nearly rectangular as possible, free from all checks and shakes, and not less than six inches in thickness.

Rubble masonry: how laid

201. All rubble masonry shall be of the dimensions shown on the plan, or as may be ordered. All walls to be laid true and by line, with stones on their natural beds, well bedded in mortar one-half (½) inch with joints carefully filled in and courses properly leveled up, care being taken to have a proper

alternation of headers and stretchers throughout, so that at least one-third of the stone shall extend through the wall, when it does not exceed four feet in thickness. The top of the masonry shall not be plastered unless so ordered.

Coping stone

202. Where coping stones are necessary, they must be furnished of a good quality of bluestone or granite. They are to be cut to the shape and dimensions given, and dressed in the manner and according to the pattern required.

Foundation stone

203. When required, foundation stones are to be furnished and laid. They must be sound and of good quality, and of such general dimensions as may be required.

Mason work after 15th of November

204. All mason work, whether brick or stone, and all concrete laid between the fifteenth day of November and the first day of April, shall be laid in mortar which has been protected against freezing either by heating the ingredients above 40° F. or protected by other equally satisfactory measures.

205. All masonry shall be covered and protected from frost in such manner as may be directed.

206. No dressing or tooling is to be done upon any stone after it is in place except by written permission of the Engineer.

Dry wall

207. Where dry wall is necessary it must be well and truly laid, and by line. Every stone must have a fair and even bearing, the courses well bonded, and all joints and crevices thoroughly pinned and wedged.

UNDERDRAINS

Position, etc., of underdrains

208. A drain shall be laid beneath the sewer only wherever the Engineer may deem it necessary. Such underdrains shall be of the size, in the location and laid to lines and grades as ordered.

It may consist either of double strength land tile or of vitrified clay pipe as called for on plans by the Engineer, and shall, whenever possible, be placed in the middle of the trench and at such depth below the grade of the sewer as will insure the work being absolutely dry during construction.

Laying underdrains

209. Both vitrified pipe and land tile shall be laid in the following manner: A trench of approximately six inches (6″) greater width than the outside diameter of underdrain shall be excavated to such a depth as will permit the laying of the underdrain at the depth and grade shown on plans or as given by the Engineer. On the bottom of this trench a plank one inch or more in thickness and six inches wide shall be placed, if so directed, on which the tile shall be laid.

Making joints

210. Every joint in the underdrain shall be clean and free from earth, dirt or solid matter. It shall then be wrapped with one layer of burlap, or two (2) of cheesecloth, soaked in pine tar in such a manner as to retain its porosity, in a strip at least six inches wide, which shall project at least two and one-half inches beyond the joint on each side. Pipe or tile shall not be brought into close contact, but a space of at least one-half inch shall be left between the ends of tiles and between end of spigot and shoulder of bell of vitrified pipes.

Filling around underdrains

211. After the joints are made up and inspected, the underdrains shall be surrounded with selected and approved screened gravel or broken stone, carefully deposited and placed, and consolidated in a manner approved by the Engineer.

Keeping underdrains clear

212. During the process of laying the underdrains and constructing the sewer, in case there is an appreciable amount of suspended matter in the water flowing in the trench or the underdrain, or in case the Engineer should deem it desirable ropes, chains or other means as may be approved for preventing clogging, filling or stopping shall be installed by the Contractor. Such means of keeping the underdrains clean and open must be regularly operated in order to keep them effective, and prevent them becoming fast and useless. The open ends of underdrains shall be kept closed with a stopper or strainer of burlap or other approved material.

Payment

213. Payment for underdrains shall be per lineal foot measured in the slope and the municipal rate per lineal foot shall include furnishing all labour, tools and materials, making the necessary excavation, placing the pipe, and doing all work incidental thereto.

MANHOLES

Positions and construction of manholes

214. Manholes shall be built at such points on the line of the sewer and of such form, thickness and materials as shown on the plans or as the Engineer may direct. The masonry shall be carried up to within six (6) inches of the existing surface of the established grade of the street at that point or to such a height as the Engineer may direct. The work shall be true to line.

Where manholes are not built up to the established grade of the street, they shall be covered where necessary, by special hammer-wrought bluestone or reinforced concrete slabs six (6) inches in thickness, to support the manhole heads. Joints of brickwork shall be neatly struck and pointed on the inside.

The details and dimensions of standard manholes of the various classes are given in the Standards for Sewer Construction Sheets Nos. .... and ...., and on the contract plans and all standard manholes shall conform thereto. Where the depth from the top of the manhole casting to the invert of the lowest sewer entering the manhole exceeds

twenty-four feet six inches (24′ 6″) the manhole shall be considered a special manhole.

Special manholes shall be constructed in accordance with the requirements and details shown upon the contract plans.

Foundation of manholes

215. The foundation of manholes for pipe sewers shall be of cement or concrete, commencing not less than six inches below the line of the inner bottom of the sewer at that point. Sewer pipes are to be built in and trimmed, when necessary, so as to be flush with the inner face of the manhole, and an arch turned over the same on a dry sand joint.

Ladders and steps

216. The Corporation shall furnish and the Contractor shall set the galvanized wrought-iron ladders and manhole steps in all manholes unless otherwise stated on plan or plans.

Manhole frames and covers

217. A cast iron manhole frame and perforated cover will be furnished by the Corporation to the Contractor, who shall fit and place the same at his own expense on manholes built to receive them. The heads shall be placed on full beds of mortar and as shown on the plans.

Weight

218. The heads of street manholes shall weigh not less than four hundred and seventy-five pounds; the cover shall weigh not less than one hundred and thirty-five pounds. For sidewalk manholes the heads shall weigh not less than three hundred pounds, and the covers shall weigh not less than one hundred pounds. Where there is no pavement, the holes in the manhole covers shall be neatly fitted by the Contractor with white pine plugs tightly driven and cut off flush with the upper and under surface thereof.

Plastering outside

219. The outside of all brick manhole shafts shall be plastered throughout with mortar one-half inch thick, consisting of one part cement and two and one-half parts sand.

Brick and concrete masonry

220. The brick masonry in the manholes shall be built with ordinary sewer brick and the construction of the brick masonry and the materials therefor shall correspond to the requirements specified under Brick Masonry. All concrete masonry shall be furnished and placed in accordance with the requirements specified under Concrete Masonry.

Special foundations

221. When ordered by the Engineer in writing the contractor shall construct special foundations of concrete masonry under the manholes. The excavation for this work shall be paid for under Extra Excavation and the Concrete shall be paid for under Extra Concrete.

Sewer not to be built in advance of manhole

222. The above described manholes, whether in brick or pipe sewers, are to be in all cases fully and completely built to a point two feet above the arch of the sewer as the work progresses, and as each is reached; and the sewers will not be allowed to be laid down beyond or in advance of any manhole not so completed except by special permission.

CATCH BASINS

Catch basins, gulleys, how constructed

223. Catch basins, gulleys or receiving basins are to be constructed in all respects complete according to the Standard for Sewer Construction sheets No. .... to ...., and as called for on the plan. They are to be constructed of concrete or of 9-inch brickwork, laid in Portland cement mortar. They are to be provided with gratings securely fitted on the street opening, and with patent cast iron flap-traps, such gratings and traps being supplied by the Corporation and fitted by the Contractor. The castings shall be placed in full beds of mortar and as shown on the plan. A bent pipe 9-inch to 12-inch in diameter, as may be called for on the plan or ordered by the Engineer, is to be built in and connected with the sewer, in course of construction, by pipes laid and jointed as may be directed.

Excavation for basins

224. The excavation for basins shall be of such dimensions as to give not less than one foot in the clear, inside of any shoring or bracing which may be needed. In case the nature of the ground be such as to render it necessary, such additional foundation as may be directed shall be built and will be paid for at the municipal rate for the various items entering into the construction thereof.

Brick and concrete masonry

225. Brick masonry in the catch basins shall be built with ordinary sewer brick, and the construction of the brick masonry and the materials therefor shall correspond to the requirements specified under brick masonry.

All concrete masonry shall be furnished in accordance with the requirements specified under Concrete Masonry.

The joints of brickwork shall be neatly struck and pointed on the inside.

The outside of all brick catch basins shall be plastered throughout with mortar one-half inch thick consisting of one part cement and two and one-half parts sand.

Sidewalks, curbs, etc., around basins

226. The Contractor shall restore and readjust, if necessary, sidewalk, curb and gutter stones around the basins with the kind now in place and of equal workmanship; concrete sidewalks to be replaced in whole squares, and flags of the proper quality not less than 5 feet by 4 feet, to be cut to accurately fit the corners of the basin-heads.

Temporary inlets to basins

227. In case the street and sidewalk should not be graded to the established grade at the point where receiving basin and manhole are built, such temporary arrangement shall be made for the inlet as may be ordered.

FLUSH TANKS

How built

228. Flush tanks shall be constructed of the dimensions and in such places as are shown on the plan; they shall be provided with siphons of the size shown and of an approved pattern. When not otherwise ordered they shall be built of concrete thoroughly plastered on the inside with neat cement, so as to be completely water-tight. They shall be covered with manhole heads of regulation weight and pattern, and when the street is not paved the Engineer may order that for three feet around such heads the streets shall be paved with granite blocks on a proper foundation of clean, sharp sand.

Pave around head

Connect flush tanks to sewer and main

229. The Contractor shall connect the flush tanks with the sewer and also with the water mains, unless otherwise ordered: the whole to be in perfect working order before acceptance. The connection with the water main to be made under a permit to be obtained by the Contractor from the Water-works Department and under its rules and inspection.

IRON WORK

Quality

230. All cast iron to be of the best quality, hard and tough, and of such strength that a bar two inches deep and one inch in width placed in supports two and a half feet apart will bear a weight of 3,000 pounds in the centre without breaking. Specimen bars for testing are to be made at each casting if required, at the Contractor's expense and shall become the property of the Engineer for the purpose of this contract.

All castings are to be perfectly solid, to have smooth, clean surface, and be free from lumps, flaws, holes or defects of any kind. They are to be accurately shaped according to drawings, and any piece which is less than the required thickness at any point shall be rejected.

No filling or plugging of any kind whatever will be allowed, and any casting found so treated will be rejected, and must forthwith be rejected at the Contractor's own expense.

Coating

231. All castings after being cleaned and inspected are to be heated to a temperature of 125 degrees Fahrenheit and thoroughly coated with Dr. Angus Smith's patent composition, properly prepared with pitch and linseed oil, and at a temperature of 300 degrees Fahrenheit; or with some other approved iron paint; until this is done all castings are to be kept under cover and perfectly free from rust. Care is to be taken that all parts are well coated with a tough, durable covering. No casting shall be coated until it has been inspected by the Engineer or his authorized agent.

Patterns

232. Patterns for cast iron manholes and manhole covers, the property of the Corporation, are now on the premises of.....
....
....

Should the Contractor use other than these they shall be at his sole cost and must be provided for in his Bid.

Inspection

233. All work is to be done to the satisfaction of the Engineer or of his assistants or agents authorized by him to act in his stead, who will have power to visit the foundry or shops where the work is being done, to examine patterns, metals and workmanship, and reject any of them not in accordance with the specifications, or otherwise unsatisfactory.

Joints

234. Joints of cast iron pipes are to be made with hot lead or lead wool, thoroughly caulked and made absolutely water-tight.

The whole of the iron work required in connection with the sewer, unless otherwise shown on the plans, is to be provided and set in place by the Contractor, and to be included in his Bid.

SPECIAL STRUCTURES

235. ....
....
....
....
....

EXPLOSIVES AND BLASTING

Explosives and blasting

236. Explosives in proper quantities shall be stored and secured in approved manner and only at places approved by the Engineer. They shall be handled with great care and shall be at all times in charge of a competent watchman.

Blasting shall be conducted so as not to endanger persons or property and the Contractor shall be held responsible for and shall make good any damage caused thereby. He shall comply with all the laws and ordinances governing this class of work. Each blast, before being fired, shall be carefully covered with heave timbers, mats or other material to prevent stone from flying. No blasting shall be done within twenty-five (25) feet of completed sewer.

INSPECTOR'S DAILY REPORT.

Contract ______________________ Date ______________________

Description of work ____

____

____

Temp. A.M. ______________________ Weather A.M. ______________________

Temp. P.M. ______________________ Weather P.M. ______________________

Class of labor working and material received on job.	Marking of Material.	Material returned to stores or left over.	Labor Hours.	Number of units or material	Wage rate per hour.	Material Unit Price.	Dr.	Cr.
Total...								

NOTE.—Inspector is required to fill in number of bags of cement, units of broken stone, sand, oil for forms, lumber, nails, etc., as accurately as possible. This is his duty.

Engineer in Charge.

INFORMATION FOR ENGINEERING DEPARTMENT

Inspector's weekly return on Project " "..........................

.... For week ending Saturday................

Contract Information.

Items.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.	

Work Completed to Date.

Give all distances from station to station as shown on the plans.

APPENDIX "B."

CONTRACTOR'S STATEMENT OF MATERIAL FOR WHICH HIS LIABILITY HAS CEASED.

Contractor's Name.............................. Contract..........

Description.	Marking.	Date Ordered.	Date Received.	Amount of Invoice.	Date Discharged.

Note.—When any bill of material is only partly discharged, the same shall be included as an attachment. The proportion of total liability shall be indicated on the form under "Date Discharged."

APPENDIX "A."

CONTRACTOR'S PAY SHEET AND LIST OF MATERIAL RECEIVED ON WORKS.

Name of Contractor...................... Project "......................."

Month of			Labor.																																	
	Name.	Employment.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Days.	Rate.	Total.
	Total																																			

Summary: Previous labor............ Labor for the month of...........$........ Contractor's total liability to date..............

Previous material......... Material for the month of.................. Principal, Total payment made to date.........

Over

APPENDIX "A."

MATERIAL RECEIVED ON THE WORKS.

Material delivered to the Stores.

Date Received.	Description.	Marking.	Purchased from	Date Received.	Description.	Marking.	Purchased from.
				Certified	correct. Inspector.		

Note: Invoice amounts to be inserted where possible.

STATEMENT—Summary of Contractor's Costs.

Description of Work.	Labor and Material.						Unit Costs.		
	Class of Labor Material Summary.	Hours.	Number of Units.	Wage rate per hour.	Material Unit price.	Total Expenditure.	Quantity.	Calculated Unit Price.	Total Amount.
NOTE.—Allow 20% interest and depreciation, upon capitalized Value of Plant to these figures for number of days including moving.									

APPENDIX "A"

APPENDIX "A"

The reports appearing in this Appendix were received from the Secretaries of the Local Boards of Health of the cities and towns of the Province of Ontario, in conformity with section 23, ss. 3, of the Public Health Act, and have been edited by the Secretary of the Board.

FORT WILLIAM.

Dr. E. B. Oliver, M.O.H.

In accordance with the provisions of the Ontario Public Health Act, I beg to submit herewith my annual report for the year ending October 31st, 1916.

The great outstanding feature of the report this year is that it shows a reduction in the number of cases and deaths from typhoid fever to a point which is the lowest this municipality has ever had. This, gentlemen, is a delightful condition of affairs. It has been brought about in the first place by the installation of our present excellent system of waterworks; in the second place by the careful supervision of our dairies and in other ways by the construction of manure boxes to comply with the provisions of the Ontario Public Health Act, by the by-law adopting a standard privy for our city and by the educational campaign that has been carried on for the proper care of garbage by the householder. The whole duty of a health department is to lessen the morbidity, and, therefore, mortality. While our statistics will show that the total death rate is higher this year than last this can be shown to be due to causes outside our immediate control.

But we must not rest because we have succeeded in bringing the typhoid rate down to a low level. The other side of the picture shows plenty of work to be done. There were five less deaths from tuberculosis of the lungs reported this year than last. There were sixteen more deaths from whooping cough. There were several more from measles and diphtheria.

Education is the only method by which we can reach the people and prevent this useless waste of human life from whooping cough and measles. And the only method of education that will reach home is to employ a visiting health nurse to visit in the homes. When I tell you that with one exception all deaths from whooping cough were those of children under two years of age you can understand this measure. The permanent employment of a visiting health nurse on your staff will help to cut down this infant mortality. No other method of dealing with the problem has shown better results.

Our infant mortality is higher this year than last. As is always the case, the coal dock region is the part of the city that contributes most largely. Of the twenty-eight deaths occurring in July and August, twenty-two were from the region we know as the "coal dock." We will always have this region responsible for the large number of deaths until the sanitation of the part is improved. It is not by chance these infants die. It is purely a matter of cause and effect.

The Anti-Tuberculosis Society which works in harmony with the health department has assisted in the campaign against tuberculosis. But so much remains to be done that there will be no success worthy the name until our citizens realize that every year many of our people fall by the wayside from this dread plague and that every death is due to carelessness and ignorance.

The work of abolishing the privies remains at a standstill. There were eighteen less sanitary connections made than in the previous year. I am including in this report a short report from the superintendent of the cleansing department.

As in former years we have kept well within our estimate.

Our vital statistics show the following:

Deaths, including non-residents, three hundred and twenty-one; deaths of non-residents, by this is meant residents of other municipalities who died there and whose deaths are registered in our municipality, forty-two; still births, thirty-two.

Estimated population	18,850
Death rate per 1,000 (including non-residents)	15.33
Death rate per 1,000 (excluding non-residents)	13.26
Death rate per 1,000 (including non-residents and still births)	17.03

The rate 13.26 includes all who died in the municipality. In many cases they were travellers, as for example, the three men killed in the C.P.R. wreck in December. So our actual death rate would be below this.

Birth rate per 1,000 (excluding still births)	47.85

This is 3.59 lower than last year.

Infant mortality rate per 1,000 births	117.51

This is practically the same as it was in 1914, but it is considerably higher than last year when the rate was 85.05 per 1,000.

Thirteen regularly called meetings of the board were held during the year. Several informal meetings were held.

Communicable Diseases.

Smallpox.—There were but three cases of this disease during the year. Two were discovered in a local hotel and one was located on a troop train from the west. No contacts took the disease which was of a mild type.

Year.	Cases Reported.	Deaths.
1913	11	0
1914	0	0
1915	8	0
1916	3	0

Scarlet Fever.—There were but four cases of this disease with no deaths.

Year.	Cases Reported.	Deaths.
1912	12	0
1913	45	1
1914	110	2
1915	18	0
1916	4	0

Diphtheria.—There were thirty-three cases of this disease reported during the year with five deaths. This is the largest number of cases ever reported in one year and the highest death rate since 1910. There is no doubt that the lessened resistance due to a previous attack of measles allowed the disease to develop in many cases. One of the deaths occurred out of the city and was reported here.

Year.	Cases Reported.	Deaths.
1912	12	0
1913	19	2
1914	24	2
1915	25	2
1916	33	5

Measles.—The largest number of cases of this disease ever reported in one year were registered. Unfortunately there were seven deaths. Five of these were in the "coal dock." All were under the age of two years.

Year.	Cases Reported.	Deaths.
1912	98	0
1913	144	0
1914	279	1
1915	8	0
1916	581	7

Whooping Cough.—The number of cases of this disease is greater than the total of all previous years combined. There were seventeen deaths. Sixteen of the fatal cases were under two years of age. The other was three years of age.

Year.	Cases Reported.	Deaths.
1912	4	8
1913	1	3
1914	0	1
1915	33	2
1916	196	17

Poliomyelitis.—This is the first year that cases of this disease have been reported as poliomyelitis. Probably cases of this disease were reported under another name. The prevalence of this disease over wide areas this year caused a stricter investigation into conditions, thus producing better reports. There were ten cases originating in the city and one in Neebing, treated here. The fatality rate coincides with that of other cities that have had cases.

Year.	Cases Reported.	Deaths.
1916	11	3

Erysipelas.—Below are the statistics of this disease during the last three years.

Year.	Cases Reported.	Deaths.
1914	11	4
1915	5	0
1916	6	1

Mumps.

Year.	Cases Reported.	Deaths.
1914	3	0
1915	3	0
1916	16	0

Chickenpox.

Year.	Cases Reported.	Deaths.
1912	17	0
1913	19	0
1914	52	0
1915	94	0
1916	51	0

Typhoid Fever.—Last year I stated that we had the lowest number of cases of this disease we had ever had. I am pleased to be able to say that this year the number of cases is five less than last year. There were but two deaths, giving us the lowest death rate we have ever had, 10.60 per 100,000.

Year.	Cases Reported.	Deaths.
1912	48	6
1913	80	5
1914	35	5
1915	23	7
1916	18	2

Pulmonary Tuberculosis.—There were eighteen deaths from this disease reported for the year. This is five less than last year.

Year.	Cases Reported.	Deaths.
1913	12	19
1914	17	11
1915	28	23
1916	19	18

MISS K. SPEARING, SCHOOL NURSE.

As requested by you, I take pleasure in handing you herewith my report for the seven months of the school year ending October 31st, 1916.

Month.	Inspections.	Instructions.	Exclusions.	Home Calls.
1915				
November	1,284	104	20	70
December	544	35	12	22
1916				
January	1,023	76	30	35
February	1,122	86	14	39
March	1,213	330	18	31
April	660	105	8	31
May	760	118	14	76
September	572	....	29	29
October	713	....	13	47
	7,891	854	158	380

Exclusions were for pediculosis, chickenpox, severe coughs and colds, swollen glands, ringworm, whooping cough, sore eyes, sore throat, measles, uncleanness, etc.

Medical Relief.

The following is the report of medical relief work for the year.

Month.	Visits Made.	Office Consultations.	Obstetric Cases Conducted.	Anæsthetics Administered.
1915				
November	13	5	3	
December	17	4		
1916				
January	11	11	....	1
February	22	6		
March	15	6		
April	4	3		
May	3	4		
June	4	4		
July	2	4		
August	....	4		
September	2	1		
October	2	1	....	2
	95	53	3	3

Laboratory Report.

The work in the laboratory has increased this year. An up-to-date incubator was added thus facilitating the diphtheria work.

There were two hundred and sixty-two examinations for dirt and butter fat of milk taken from licensed dairies. The result of these tests is here shown.

Name of Vendor.	No. of Tests.	Clean.	Slightly Dirty.	Dirty.	Fat.
Brown Bros	8	8	....	....	3.27
H. Crabtree	16	13	2	1	3.61
City Dairy	23	19	2	2	3.37
J. A. Kellough	27	26	1	....	3.70
R. Lewtas	7	4	1	2	3.43
F. McCarthy	20	17	3	....	3.46
Jas. Otway	19	17	2	....	3.51
Jno. Otway	13	13	....	....	3.61
Ed. Otway	10	10	....	....	3.32
J. Parker	16	13	3	....	3.83
A. Rasilanen	7	5	1	1	3.08
F. Scollie	35	33	1	1	3.44
R. Sheehan	8	4	3	1	3.45
D. R. Thompson	24	22	2	....	3.27
B. Webster	13	12	1	....	3.16
F. Widnall	16	16	....	....	3.60

Comparison for cleanliness should not be made without taking into consideration the number of samples taken. Nevertheless it is noteworthy that of forty-seven samples taken from four dealers all were clean. Six dealers fell below 3.4 per cent. for butter fat. Ten were above 3.4 per cent., while the minimum allowed by law (Ontario Milk Act) is 3.0 per cent. I do not consider anything below 3.4 per cent. good milk.

Each of two dealers had two dirty samples. This is not a good showing for these men.

Fifty-one other samples of cows' milk were examined, mostly from private sources.

Five specimens of breast milk were examined.

Twenty-five samples of cream were examined.

One hundred and one swabs were examined for diphtheria infection as follows:

	Positive.	Negative.	Total
For diagnosis	21	45	66
For release	3	32	35

Fifty-one examinations of sputum for T. B. were made of which seven were positive and forty-one were negative.

Seventeen urinalyses were made on account of medical relief.

The total of work done is summarized as follows:

Samples of milk examined	313
Samples of breast milk examined	5
Samples of cream examined	25
Diphtheria swabs examined	101
Specimens of sputum examined	51
Urinalyses for medical relief cases	17
Total	512

W. E. Stanley, Sanitary Inspector.

I beg to submit my annual report for the year ending October 31st, 1916.

Nuisances.

The following table shows the number and character of nuisances dealt with during the year:

Dealt with by written notice.

Insanitary Premises.	Animals not properly kept.	Plumbing defects.	Garbage nuisances.	Privy nuisances.	Manure nuisances.	Total.
14	10	13	37	3	34	111

Complaints of nuisances have been very few during the year. The number of written notices is small. I find that in most cases nuisances can be dealt with by a personal interview. In speaking of nuisances I must exclude the coal dock section as there are many nuisances existing which cannot be dealt with until sewer connections are put in. It was found necessary to prosecute in only one case for neglect in the abatement of nuisances, the defendant being fined one dollar and costs. Owing to the exodus of the foreign population overcrowding is not by any means so prevalent as it was. One of the greatest nuisances is the keeping of chickens. Several instances have been found where they were hatched and kept in the house.

Three hundied and fourteen visits were made in connection with nuisances.

Infectious Diseases.

The year has been a very busy one in connection with infectious diseases, owing to the prevalence of measles. Six hundred and fifty-nine visits were made in this connection.

Twenty-eight houses were fumigated with a capacity of 95,000 cubic feet. A troop train was also fumigated.

Dairies and Cowbarns.

During the past year there has been a reduction in the number of retailers of milk. Owing to constant supervision a marked improvement has been made in the cleanliness and fat content of milk, one prosecution only having been instituted for dirty milk.

The old type of cowstable with its low ceiling, wood floors, defective lighting and ventilation has been entirely eliminated. Seven hundred and eight inspections have been made during the year. This number is not up to the number of inspections of previous years owing to the fact that this year I have no assistant. On the other hand such frequent inspections are not necessary owing to the better class of building.

I made one hundred examinations of milk for dirt and temperature in the dairies of those who secure milk from the country districts. This milk is constantly improving and now compares favorably with milk produced in the city.

After much persuasion the city milk vendors have been induced to carry ice during the hot summer months.

If we are to believe the statements of dairy experts there must be a certain percentage of dairy cattle in this district affected with tuberculosis and I should like to see all cattle put through the tuberculin test. I am sure the results would amply justify the expense incurred.

The two largest dealers who deal exclusively with farmers' supplies have put in pasteurizers and all their milk retailed is sold in bottles. We have still with us the old pattern of person—usually a foreigner—who keeps one or two cows ostensibly for his own use, but who undoubtedly sells a considerable amount to persons who call for it. This is a difficult matter with which to deal.

I have collected during the year from the rigs of milk retailers two hundred and one samples of milk for the purpose of laboratory examination.

Seven hundred and eight inspections were made.

Restaurants.

There has been a considerable reduction in the number of licensed restaurants. There are now ten as against twenty-five last year. They are kept under constant supervision and generally speaking are well conducted and kept satisfactorily and in a sanitary manner.

Four hundred and seventy-four inspections were made.

Store and Food Supplies.

All stores dealing with food stuffs are kept under constant supervision. Bread retailers and bakeries are regularly inspected and absolute cleanliness insisted upon. Bread is frequently weighed and kept up to the lawful standard weight.

Three hundred and seven inspections were made to bakeries alone.

The following articles were condemned as being unfit for food (exclusive of meat). 420 doz. of tinned fruit; 170 gals. of pickles; 150 lbs. of tea; 240 lbs. of lard; 100 lbs. of sugar.

Ice cream and candy stores are regularly visited, one hundred and sixty-six inspections having been made.

Plumbing Installations.

During the past year no plumbing has been installed by notice. This is much to be regretted as our most serious nuisances arise from the lack of sanitary conveniences. The ground upon which houses are built without sanitary conveniences is sodden with sewage which is a constant menace to the health of the inmates, particularly to infants, a fact which is amply borne out by the mortality statistics. It is a most difficult matter to induce people who live under such conditions to keep their premises clean and tidy.

Thirty-two installations have been made by the request of the owners, the work being done by the city.

Abattoir Report.

During the year the abattoir has been in constant operation although handicapped by deep snow in the early part of the year which prevented cattle being brought in from the farms and a fire which occurred in September. The work has been carried on satisfactorily and the results amply justify its establishment.

For the first few months tubercular cattle slaughtered were, if not numerous, more commonly found than they are now, when one is rarely found. This I attribute to the constant inspections, every animal slaughtered being inspected and condemned if diseased. The dealer will consequently not now take any risk and refuses to buy any suspicious looking animals.

A great improvement was made to the building by the partition of the meat store and the forming of a cold storage at a cost of $102.20. The owners allowed a rebate of two months' rent amounting to $90.00 towards this cost. The users of the abattoir furnish their own ice.

The viscera of three animals was condemned, also six head of cattle. Three were affected with tuberculosis and three had been killed after being injured.

The number of animals slaughtered was 1,049, a summary of which and a table of the revenue and expenditure for the year follows:

Date.	Cattle.	Calves.	Sheep.	Hogs.	Total.	Revenue.	Credits.	Expenditure.
1915								
November	83	33	12	58	186	118 55	14 15	126 10
December.......	82	44	....	40	166	161 25	....	163 70
1916								
January	43	9	....	23	65	67 90	....	76 30
February	33	16	....	11	60	39 50	11 95	76 85
March	30	16	....	......	46	34 00	....	66 30
April	27	31	....	......	58	33 50	....	53 95
May	33	43	2	1	79	45 25	....	55 60
June............	33	41	3	9	86	45 95	....	73 67
July	36	18	6	5	65	43 95	....	52 30
August	43	33	1	......	77	51 50	90 00	195 32
September	40	21	14	......	75	46 35	....	97 15
October.........	60	21	5	......	86	66 00	41 15	65 65
	543	326	43	147	1,049	753 70	157 25	1,102 89
								157 25
								945 64
								753 70
					Debit balance.....	191 94	....	191 94
						$945 64	....	$945 64

H. J. Paddington, Cleansing Superintendent.

Herewith I beg to submit a report on that portion of our work which has a bearing on the work of the health department.

Garbage Collection.

Much has been done during this year to have the requirements of the law concerning receptacles more faithfully carried out. The progress made, however, is not as great as is required. The authorities were mostly concerned with having the receptacle placed on the rear of the lot, their view being an economical one only. As a matter of fact, the question of a proper covered receptacle is of more economical importance in addition to being a direct preventive against disease. It is our intention to have this matter dealt with in future as a nuisance. Whether the intention is carried out or not rests entirely with the authorities.

It is possible that during the early part of 1917 the question will be raised of collecting garbage and nightsoil by contract. I would advise against reverting to a system which is condemned by all leading experts of the present day.

Nightsoil Collection.

The number of privies has been slightly reduced during this year. This is due, not to the increased number of sanitary connections put in, but to the very few new shacks which have been built.

The number of sanitary connections made was thirty-two as against fifty in 1915, whilst five houses have been added to the collection as against thirty in 1915. The sanitary connections made also reduces the number of privies on sewered streets from six hundred and forty to six hundred and twenty-six.

Nuisance Ground.

The condition of the nuisance ground has never been better than during this year. The suggestion of Dr. George to cover the trench contents every few days has been carried out with the result that the number of flies has been reduced to a minimum.

Spring Clean Up.

In spite of an excessive snowfall during last winter the quantity of refuse removed in the clean up campaign this year was less than ever before. The main reason for this is the cultivation of back gardens. When a garden is under cultivation the odds

and ends of rubbish, which under different conditions would be left lying around, are regularly picked up and put in the garbage can or in most cases burnt by the owner. To all appearances the clean up campaign will soon be necessary only for those who take no interest in a clean city.

Miss F. K. Fisher, Visiting Health Nurse.

I beg to submit my report for the four and one-half months I was on your staff (May 15th to September 30th).

Conditions seem to be improving in the coal dock section, in which part of the city most of my work is carried on. Overcrowding is the great drawback to the proper upbringing of the infant.

Below will be found a summary of the work done:

Month.	No. of visits.	New babes visited.	Breast fed.	Mod. milk.	Cond. milk.	Patent foods.	Mixed food.	Special calls.
May	120	....	80	12	5	1	22	....
June	369	....	210	32	8	10	82	27
July	472	102	74	20	2	2	4	72
August	481	81	68	6	3	4	....	209
September	392	63	58	2	....	3	....	....
	1,834	246	490	72	18	20	108	308

The total number of visits made was 1,834. The cost per visit was 18.73 cents, made up as follows:

Salary of nurse	$325 00
Auto service	8 50
Car tickets	10 00
	$343 50

Births Registered in the City of Fort William

For the Year ending October 31st, 1916.

——	Males.	Females.	Total.	Twins.	Triplets.
1915					
November	45	48	93	1	
December	50	48	98	....	1
1916					
January	45	30	75	2	
February	40	36	76	2	
March	42	34	76	2	
April	27	32	59		
May	47	26	73	2	
June	29	37	66		
July	31	42	73		
August	33	38	71		
September	36	28	64	1	
October	40	38	78	1	
	465	437	902	11	1

STILL BIRTHS

—	Male.	Female.	Total.
1915			
November	2	....	2
December	2	1	3
1916			
January	1	....	1
February	3	2	5
March	2	1	3
April	....	....	....
May	2	2	4
June	1	3	4
July	1	....	1
August	2	1	3
September	2	1	3
October	2	1	3
	20	12	32

CAUSE OF MORTALITY.

Infants under one year.

Number on International List.	—	—
104	Diarrhœa and Enteritis (under two years)	30
151	Congenital Debility, etc	25
91	Bronchopneumonia	14
8	Whooping Cough	8
152	Other diseases peculiar to early infancy	6
71	Convulsions of infants	4
92	Pneumonia	4
6	Measles	3
76	Diseases of the ears	2
110	Other diseases of the intestines	2
150	Congenital malformations	2
189	Cause of death not specified	1
10	Influenza	1
31	Abdominal Tuberculosis	1
61	Meningitis	1
89	Acute Bronchitis	1
103	Other diseases of the stomach	1

GALT.

DR. J. H. RADFORD, M.O.H.

The Medical Officer of Health of the City of Galt begs herewith to submit his report for the months of July, August, September, October and November, and in doing so would again draw your attention (as has been heretofore done by my predecessor, the late Dr. Vardon), to the great difficulty in securing adequate service for the collection and disposal of nightsoil due principally to the fact that it is absolutely impossible to educate the citizens as to the necessity of their paying for the service in advance.

In my opinion the only way to overcome this difficulty regarding the payment is to petition the City Council to charge the amount necessary in the taxes as is done in connection with the garbage system or to pass a by-law, as was done in the town of Smith's Falls, compelling each owner to connect with the sewer as and when the Local Board of Health may direct wherever it is possible to make such connections.

The quantity and quality of our milk supply is a matter of very great importance to the citizens generally but as health officers, we are only concerned with the quality,

and I regret very much to be compelled to state that I am not satisfied with the quality either from the low butter fat tests or the dirt tests. In the former I am pleased to state that it has greatly improved, whilst in the latter I cannot see much improvement. I look upon clean milk as of very much greater importance to the citizens than butter fat and I trust that the vendors will insist on the producers supplying them with clean, wholesome milk, as they are primarily responsible to the Board.

The water supply is adequate and free from contamination of any kind.

The Swiss Cottage has been opened for a period of sixteen days during the month of July for the purpose of caring for a case of diphtheria, and for a similar period in the early part of the month of October, for the care of a case of scarlet fever. Since that time it has been open continuously for the reception and care of the soldiers connected with the 122nd Battalion suffering from measles and a contagious form of sore throat.

The work done by the public school nurse has been entirely satisfactory to me and in my opinion the Board is to be congratulated and commended on their appointment of such an efficient young lady.

Until six weeks ago the city was comparatively free from any contagious diseases and I was beginning to think that the year would end without any serious epidemic, but alas, my hopes and wishes were blighted by the sudden outbreak of german measles among the 122nd Battalion, which outbreak has extended to almost every part of the city.

We have also an epidemic of chickenpox, the extent of which will be shown by the report of the division registrar.

In conclusion, I hope and trust that the medical men of the city and the citizens generally will give us every assistance possible for the purpose of stamping out these two epidemics.

R. A. Wilson, Sanitary Inspector.

I herewith beg to submit my report for the year 1916.

During the year I have visited all parts of the city and while my other duties prevented my visiting each individual place, I satisfied myself that I covered the ground pretty thoroughly.

Many places were found in an unsanitary condition that have been remedied, in some instances though I had to make three visits to see that my orders were carried out.

I attended to every complaint that was made to me and where such complaints were justified I saw that the nuisance was abated.

I visited all restaurants and laundries once a month and saw that those places were kept in a proper sanitary condition.

I have put up 145 placards on houses where communicable diseases existed, as follows: For measles, 143; for scarlet fever, 1; for typhoid fever, 1; 21 placards are now on houses for measles.

I have disinfected 17 houses as follows: For tuberculosis, 6; for measles, 4; for diphtheria, 4; for cancer, 2; for erysipelas, 1.

I have also collected samples of milk from all milk vendors at nine different times and had tests made.

GUELPH.

Dr. H. O. Howitt, M.O.H.

I beg to submit my report for the year ending November 30th, 1916.

Contents of Report.

1. The Infectious Fevers.
2. The Milk Tests.
3. The Water Supply.

The records of deaths, marriages and births do not now pass through this office so their tabulation is omitted from this report. We, of course, have to deal with the infectious diseases, and we note that from the year commencing November 1st, 1915, and ending October 31st, 1916, there were 955 cases of an infectious nature reported to this Board.

Scarlet Fever.—November, three cases; December, one case; January, 1916, one case; February, two cases; March, two cases; April, one case; May, two cases; June, one case; July, none; August, one case; September, one case; October, one case; total, 16. No deaths.

Diphtheria.—November, one case; December, two cases; January, one case; February, three cases; March, none; April, none; May, none; June, one case; July, one case; August, none; September, none; October, none; total, nine cases. One death.

Measles.—November, none; December, three cases; January, seventeen cases; February one hundred and thirty-one cases; March, four hundred and fifty cases; April, two hundred and twenty-nine cases; May, fifty-two cases; June fourteen cases; July, none; August, none; September, none; October, none; total, eight hundred and ninety-six cases. Nine deaths.

German Measles.—There were four cases in February, 1916, but in no other month was there a case. No deaths.

Chickenpox.—November, none; December, one case; January, two cases; February, one case; March, one case; but no other throughout the year and no deaths.

Typhoid Fever.—There were two cases in February and no other cases throughout the year. No deaths.

This is a good record and is, perhaps, an excellent testimonial to the efficiency of the disinfectant which is daily added to the water, e.g.—chlorination.

Whooping Cough.—April, four cases; August, two cases; October, four cases; no others throughout the year. Total, ten cases. No deaths.

Mumps.—August, one case; October, nine cases. Total ten cases. One death.

Cerebro-Spinal Meningitis.—October. one case; total, one case. One death.

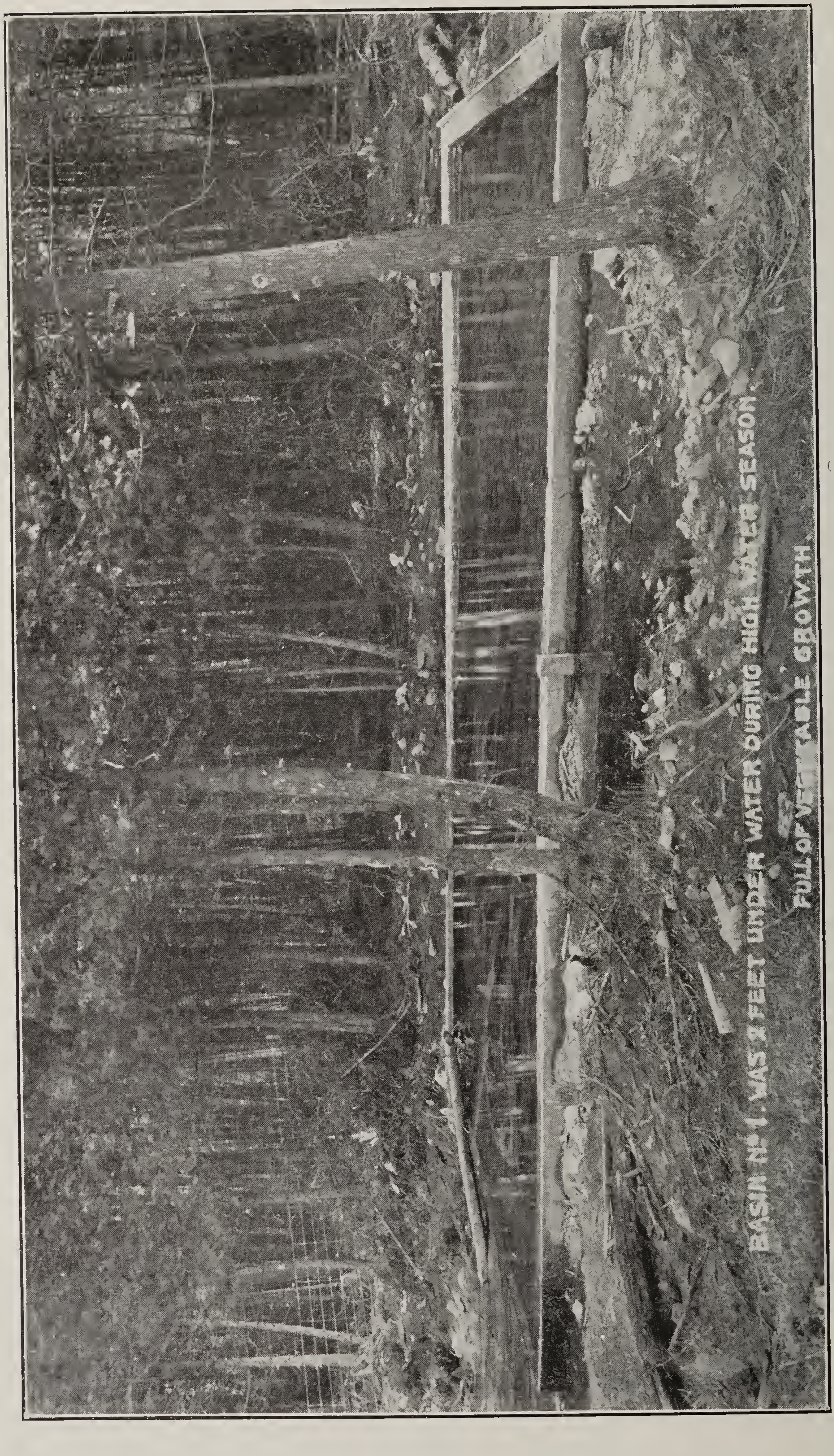
With the exception of the measles, this is a good record, leaving less than sixty cases for the other communicable diseases combined. It is to be noted that in Guelph, during the year just ended, that measles caused three times as many deaths as all other infectious diseases combined.

The reason for such a large number of cases of measles is to be attributed to persons who concealed the presence of measles early in December, 1915, and in January, 1916. I feel that it is due to the fact that some mild cases were concealed that this disease got its start and caused nine deaths, possible unnecessary deaths. I say unnecessary not meaning that they were not properly treated, but meaning that they might not have contracted the disease had notification and isolation taken place.

Milk Tests.

Three per cent. butter fats is a fairly good test. Anything up to near three and one-half is good and above this is excellent. Anything below 2.5 per cent. butter fats is a very poor test indeed. The following is the result of the standing of the various milk dealers as judged by tests made last summer.

License No.	Vendor's Name.	% Butter Fat.
17	Geo. Burns	3.25
5	E. Hudson	3.75
....	J. Sharp	2.85
1	J. Sharp	2.85
24	F. Boreham	4.01
46	H. McKinnon	2.07
18	— Cross	3.03
....	J. Stout (Jr.)	2.95
26	Thos. Croft	4.06
2	Farr Bros	3.07
25	W. Telford	3.75
20	Yates & Darnell	3.65
17	Geo. Bowles	3.02
....	Model Dairy (Pasteurized)	3.05
....	" " (Not Pasteurized)	3.02
14	Thos. Heeley	3.01
19	W. Poole	3.05
4	J. Hattin	4.09
7	H. Carter	3.00
10	W. Noble	3.75
27	W. Green	3.09
13	W. Newstead	3.03
23	Alice Cass	3.07
18	J. Stout (Sr.)	3.08
12	Jas. Kaine	4.25



Basin No. 1. Guelph water supply under old conditions.

The City's Water Supply.

Then last, but in retrospect most important, we come to the water supply.

The conclusion is forced upon us that the great mistake was made when the water pipe line was first installed. The fault lies in the construction of the line. Had the commissioners in office, at that time insisted upon an iron pipe, or some other material of impermeable substance—the contamination, broken pipes, and leaks would not have occupied our attention as they have in the past two years. The engineers to-day estimate the cost of installing iron pipe, as very much in excess of $75,000.00.

So the citizens are confronted with only two alternatives.

(1) To go on as we are, with a disinfectant (chlorination) in the water all the time.

(2) Or to spend again an amount of money, almost as much as the original cost of the water line.

(1) If we keep on using the present patched up line, then daily, in fact, constantly, chlorination must go on indefinitely. This has been done ever since this Board, and the Provincial Board of Health stepped in, in December, 1914; and immediately after we were advised by the Provincial Board of Health, to placard the city warning the citizens of the condition of the water supply, e.g., that the water was contaminated.

There is no danger in using water that is "chlorinated." The addition of the chlorine destroys the harmful germs that may be in the water, and in so doing makes water otherwise harmful—quite safe to drink. Toronto has to chlorinate its water, and many towns and cities in America find it necessary to do the same. The soldiers on active service at the front often have their drinking water so treated. Had chlorination of water been used in South Africa during the war, probably many thousands of lives might have been saved and typhoid fever less known. We in Guelph, have consumed chlorinated water for two years and with few complaints, except during the early months of its operation. Chlorination, whether we like it or not, makes the water safe to drink. If we do not like it, then we are confronted with the other alternative, number (2) e.g., building a new pipe line and replacing the present one. The engineers have recently shocked the taxpayers by estimating the cost at $75,000.00 as the expense of supplying water "pure crystalline as at the springs."

The Provincial Board of Health naturally could not be expected to order us to adopt No. 2, if the addition of chlorine makes the present supply safe to drink, and we all as taxpayers, feel relieved. The discussions aroused by this Board have resulted in many improvements to the line. Serious sources of contamination have been stopped, many holes in the line have been attended to, the collecting basins made as safe as possible. The head springs were "prospected" for and located—no one connected with the Water Commission was able to state exactly where the head springs were.

In short, much work was completed and useful information gained, which evidently could only be obtained by a general stocktaking like the one of the last few months. Much work was done on the "new line," which was opened this year for the first time. That is, the one freshly added from the Stone and Carter farms. You will remember that we were astounded by the revelations there; the discovery of the fact that the Torrance Creek (condemned a year before and shut out from the old line) was at liberty to enter, and did freely enter the newly constructed line. This opening was the subject of the most important of the photographs taken at that time. The others are with the records of the investigation and speak for themselves.

In short, our work was hard at times to proceed with but now it is all in black and white; and open to any person open to conviction.

There remain only two things possible to be done.

1—Go on with chlorine in the water (which is safe).

2—Or spend thousands of dollars on a first-class line (The engineers were asked for an estimation of the cost and say $75,000.00 is the minimum).

Then, Gentlemen, I feel that this Board has done a valuable service to the City even if the result has been the revelation of the fact that the water system as it is, is in a way "a shattered idol." It rubs us all against the grain, nevertheless we would be untrue to our positions were we to create any other impression than the correct one.

I commend Major Merewether for his splendid work throughout the year and you all for your valuable assistance.

HAMILTON.

Dr. J. Roberts, M.O.H.

Below please find report of the Medical Officer of Health for statistical year, beginning November 1st, 1915, and ending October 31st, 1916.

Vital Statistics.

—	1915.		1916.	
	Births.	Deaths.	Births.	Deaths.
November	239	106	220	112
December	231	135	240	110
January	236	92	242	162
February	243	99	243	136
March	284	119	271	138
April	231	114	229	133
May	248	104	242	97
June	231	72	233	96
July	241	118	291	98
August	239	147	244	117
September	230	118	221	112
October	243	117	233	111
Total	2,896	1,341	2,909	1,422

Summary of Communicable Diseases Reported From November 1st, 1915, to October 31st, 1916.

Diseases.	1915.		1916										
	Nov.	Dec.	Jan.	Feb.	Mar	Apl.	May	June	July	Aug.	Sep.	Oct.	Total.
Diphtheria	42	27	24	17	16	9	15	9	4	3	7	50	223
Mumps	14	27	20	86	249	157	121	41	10	2	1	5	733
Chickenpox	23	29	46	48	51	25	38	21	11	2	3	10	307
Consumption	14	9	12	16	10	13	13	19	14	23	6	14	163
Poliomyelitis	......	......	....	....	....	....	....	......	1	......	14	2	17
Whoopingcough	34	39	47	84	91	51	73	32	20	5	10	12	489
Scarlet fever	12	12	12	17	8	5	5	2	......	5	......	6	84
Measles	5	7	34	44	52	107	282	253	158	18	22	51	1,033
Erysipelas	......	4	1	2	3	....	2	......	1	......	......	......	13
Typhoid fever	3	1	1	1	....	....	....	......	......	1	7	2	16
Totals	147	155	197	315	480	367	549	377	219	59	70	152	3,087

SHOWING DEATHS FROM COMMUNICABLE DISEASE FROM NOVEMBER 1ST, 1915, TO OCTOBER 31ST, 1916.

Diseases.	1915.		1916										
	Nov.	Dec.	Jan.	Feb.	Mar	Apl.	May	June	July	Aug.	Sept.	Oct.	Total.
Diphtheria....	3	3	5	2	7	4	2	1	......	......	2	6	35
Typhoid fever.	......	......	....	2	....	1	....	......	......	......	......	......	3
Measles	......	......	....	....	2	2	....	......	3	......	......	......	7
Whoopingcough	2	......	1	....	....	....	....	......	1	......	......	1	5
Erysipelas....	......	......	....	....	1	1	....	......	.....	......	......	......	2
La Grippe	......	......	7	5	1	....	....	......	......	......	......	......	13
Consumption..	4	3	2	14	8	11	5	6	9	9	1	5	77
Tuberculosis (other forms)	1	2	....	2	2	1	2	2	......	......	1	1	14
Cerebro-spinal Meningitis ..	1	1	1	1	1	....	....	1	......	......	......	......	6
Totals....	11	9	16	26	22	20	9	10	13	9	4	13	162

DR. W. R. JAFFREY, BACTERIOLOGIST.

I herewith report work done in the city laboratories for the year ending October 31st, 1916.

Summary.	Positive.	Negative.	Total.	Total, 1915.
Wassermanns........................	214	435	649	569
Throat Cultures........................	322	2,301	2,623	1,822
Sputums........................	88	452	540	594
Widals	47	102	149	192
G. C. Smears........................	32	373	405	133

Specimens of milk from various supplies were examined bacteriologically in conjunction with the field work of the food inspector.

Specimens of water from the city supply were examined daily and at no time did they show serious contamination. During the hot weather numerous surveys were made of the supply and numerous samples came in from private supplies.

Specimens of market meats were examined at various times for the food inspector.

Total examinations for the year are 4,366, an increase of 1,056 over last year's total of 3,310.

KITCHENER.

DR. J. MCGILLAWEE, M.O.H.

I beg to submit herewith my annual report for the year 1916.

There were 246 deaths registered during the year.

There were nine deaths from pulmonary tuberculosis, one death from tubercular meningitis and one from tubercular peritonitis.

There were six deaths from cancer, which is an improvement on 1915, when there were 16 deaths registered from cancer.

There was an epidemic of measles during the early part of the year, which, in spite of all efforts to control, spread over the entire city. There were between 700 and 800 cases quarantined.

There were two deaths from pneumonia following measles, which is a good showing considering the number of cases.

There were several cases of typhoid treated in the Kitchener and Waterloo Hospital, but in none of the cases was the disease contracted in the city. No deaths from typhoid.

There were eighteen cases of diphtheria with three deaths; one death from malignant diphtheria. one from paralysis following diphtheria, and in the third case the physician was called too late.

There were two cases of infantile paralysis, both of which recovered.

The milk tests have, on the whole, been satisfactory. A milk by-law was passed by the City Council in October. The by-law is at present in the hands of the Provincial Department of Agriculture for approval.

The slaughter houses in the city and the slaughter houses in the surrounding country which supply meat to the city were inspected by the Board at different times during the year and in several cases necessary improvements were ordered.

We had considerable trouble with the city water during the summer but no serious effects. With the plans that are at present under way, the trouble will be avoided in future.

KINGSTON.

Dr. A. R. B. Williamson, M.O.H.

I submit herewith my annual report on matters of public health which have come under my observation during the past year.

During the past two years the number of contagious diseases of serious nature has been increased owing to the fact that we have had from two to ten thousand troops stationed here at various times. During the past year there were reported to me:

Diphtheria	40	cases.
Measles	20	"
Scarlet Fever	8	"
Epidemic Meningitis	11	"
Typhoid Fever	14	"

and a few cases of chickenpox and mumps. Regarding these nothing noteworthy is to be recorded except in case of epidemic cerebro-spinal meningitis. As a rule this disease has a high mortality, but though early diagnosis by examination of the cerebro-spinal fluid, and the early employment of intraspinous intramuscular and subcutaneous injections of flexnius serum repeated two or three times in the first twenty-four hours, when necessary, the death rate has been extremely low and the disease has been rapidly stamped out by the isolation of carriers.

The maintenance of a civic incinerator, while somewhat more costly than originally estimated amply justifies the expenditure as the report of the sanitary inspector shows. The increased cost is due in part to the heavy demand made on it by the presence of troops in quarters, and further, to the fact that not only garbage but everything in the nature of filth that is combustible is collected and destroyed.

The housing question has been given careful consideration. There are many difficulties in the way of rapid improvement at the present time, one being the actual shortage of houses in the city, and another very important one is the fact that the unsanitary conditions are created by the tenant and should not be charged up to the property. Steady improvement has been made, however, particularly in the line of plumbing and fixtures. Every addition of this latter nature calls for increased sewer accommodation and brings before us more acutely the problem of sewage disposal. We have been fortunately or unfortunately situated in having a great body of fresh water at our doors into which our sewage could be dumped, but common sense tells us that there is a limit to the time that this simple method can be carried on and we can still hope to get pure drinking water from the great natural supply which is being constantly polluted by our sewage. If we continue pollution then we must adopt the best possible methods, chemical, bacterial, etc., to render the water supply fit for human consumption, and this at best, is a makeshift as it may protect us but does not protect thousands of others who have to use this source of water supply without means of purification. The sooner we face the fact that ultimately we will be compelled to forego the privilege of polluting our great lakes and rivers and install systems for the collecting and purification of our sewage the better it will be for the health of this community.

Within the past few months the Board was asked by the City Council to investigate unsanitary conditions said to prevail in two of our schools, viz.: Central and Victoria. This investigation was made and a report duly forwarded to Council.

The Council has recently brought into force a new milk by-law, drafted by the City Solicitor after consultation with those interested in the important question of pure milk supply, with the object of bringing our civic legislation up to date. In order that the

new by-law may be made effective it will be necessary to appoint some one to take charge of the collection of samples, and regular testing of these, the proper inspection of dairies, cattle, byres, etc.

It is almost superfluous to add a word of appreciation of the services of the school nurse. Through her inspection numerous cases of contagious disease, eye, skin, enlarged tonsils, defective teeth, etc., etc., have been referred to the family physicians and dentists and appropriate treatment adopted, hereby increasing the efficiency of the school work, the welfare of the children and through these the welfare of the community in general.

All of which is respectfully submitted.

LONDON.

Samuel Baker, Secretary.

I beg to report pursuant to the provisions of Section 23 of the Public Health Act, on the business before the Board of Health for the year 1916.

Sewers.—The Board of Health ordered the construction of the following sewers:

(*a*) Eleanor Street sewer.
(*b*) Linwood Avenue, Barker to Sterling Streets.
(*c*) Ashland Avenue.
(*d*) Euclid Avenue.
(*e*) Maryboro' Place.
(*f*) York, Egerton to Eva Streets.
(*g*) Duchess Avenue.
(*h*) Byron Avenue.
(*i*) Egerton Street, Hackett to Trafalgar Streets.
(*j*) Bathurst Street.
(*k*) Maryboro' Place.

The Provincial Board of Health was consulted in July on the question of having all privies connected with sewers, and also a general sewerage and sewage disposal for the City of London.

The Provincial Sanitary Engineer submitted a report to the Council on the general situation with needed improvements, and the Board with the Council have the matter under consideration.

The question of providing a sewerage system for the low-lying lands along the river is receiving consideration.

The Board has its Inspector report upon the lack of privy connections with the sanitary sewers, and ordered a rigid enforcement of the By-law which provides that every privy shall be connected with a sanitary sewer system, wherever within one hundred and fifty feet. In some cases it was necessary to take legal proceedings against the parties complained of. Of over 12,000 houses in London, more than half have outdoor toilets (London West excluded).

Water.—Dr. Hill has made weekly examinations of the city water supply, and in almost every case found absence of colon bacilli in 10 cc.

In April of 1916, the presence of colon bacilli was detected in the Springbank water supply. It was found on examination that for several days previous to the collection of the series of samples from Springbank, the spring thaws had been in progress, and considerable surface water must have entered the reservoir and ponds. This was believed to be the cause.

Again in 1916 (June) after heavy rainfalls, colon bacilli were found in small quantities in the water. Arrangements have been directed to deflect the surface water by the construction of a ditch.

On September 19th, 1916, Mr. Henderson reported that with a series of open reservoirs there is always an opportunity for a small amount of surface wash which may introduce colon bacilli, otherwise the water has been found satisfactory

Milk.—The Veterinary Inspector was instructed to have constant daily inspection of herds while housed, or during the winter months, to use a score card for classification of same; and to make a collection of samples for examination.

Vendors were notified that their license would be cancelled if they took milk from any milk producer until the premises of the said milk producer had been inspected and reported upon by the inspector.

Pamphlets were distributed to milk dealers on pasteurization.

Inspector Tancock reported the dairies as mostly in a first-class condition.

Lard Rendering.—The Board issued orders forbidding butchers to render lard in the Market House, and Inspector Lutman reported that the orders of the Board were obeyed.

Subsequently Mr. Morris was granted a permit for lard rendering in the Market House, provided he used a hood with fan and outlet satisfactory to the Board of Health, and maintain same in satisfactory operation.

Spettigue Rendering Works.—Inspector Lutman with the Provincial Inspector visited the Spettigue Rendering Works and ordered the placing of cement floors in these works.

In June, Inspector Lutman reported that the Spettigue Rendering Works was found in fair condition, but there had been nothing done with respect to improvements recommended by the Board of Health. Mr. Spettigue promised to carry these instructions out.

Toilets.—Sanitary Inspector Lutman submitted a report upon the down town places of business on February 28th, pointing out a marked deficiency. The question was referred to the Provincial Factory Inspector. At the meeting on March 17th, Dr. Hill reported that the Factory Inspector would support the Board.

The Board took up the question of the public comfort stations at Springbank Park and Port Stanley with the Commission, for a control of same, and very great improvement has been made.

Carling's Creek.—The Board took up the question of cleaning out Carling's Creek from Oxford Street to Piccadilly Street, and east of Adelaide Street. In both cases the Board was successful in having the necessary work attended to.

Paving Lanes.—The Board took up the question of paving private lanes with the Council, but as the Council had no power to deal with the matter the Board took action. In several cases the lanes were paved by the ratepayers interested.

Market House.—The Board called the attention of the Council to the unsanitary condition of the basement in the Market House, and requested improvement. Conditions have been improved by the Council.

Barber Shops.—On May 19th, after some consideration, the Board adopted Dr. Hiil's regulations respecting barber shops.

The Barber's Association and the Union have approved of the regulations.

Plumbing.—The Board took up the question of the preparation of a plumbing by-law with the Journeymen Plumbers' Association. Building Inspector Piper has been instructed to prepare a by-law and submit same to the Board of Control.

The matter is under consideration by Dr. Hill.

Complaints.—A number of complaints respecting various matters have been, from time to time, considered by the Board and dealt with.

Reports.—Dr. Hill, the Medical Officer of Health, instituted a system of reports to the Board which give a complete detailed statement of contagious diseases in the City of London. In consequence of considerable laxity in this matter in previous years, it is a difficult matter to definitely compare health conditions of 1916 with that of previous years.

Meetings.—The Board of Health held fourteen meetings at which the attendance was as follows, viz.: Chairman Somerville, 13; Mr. Hale, 5; Mr. Saunders, 10; Dr. Hill, 14; Mayor Stevenson, 6.

Report of Medical Officer of Health to the Board of Health, London, Ontario, for the Year Ending November 30th, 1916.

Herewith I have the honor of submitting, in accordance with the Public Health Act, the annual report on infectious diseases for the year ending November 30th, 1916. The excellence and completeness of this report is due to the records designed and kept by the statistician of the Institute of Public Health who has acted as vital statistician to your Board during the last year.

I think it well to call once more to your attention the fact, frequently mentioned before and also incorporated in the following report, that the apparently great increase of infectious diseases in this last year as compared with previous years is wholly an illusion depending entirely upon the immensely increased completeness of reporting cases. For instance, in certain previous years only those cases of measles which died were reported. This year practically every case of measles was reported. This statement regarding the apparent increase of cases is no mere guess work, for while we have no official records of previous years worth considering, we do have in the census of public school children conducted by the Institute of Public Health in 1912 and 1913, a very complete record of infectious diseases in London for past years. This investigation showed that the average number of cases of infectious diseases per year in London (say population 50,000) must have been as follows:

Chickenpox	about 500
Measles	about 800
Mumps	about 500
Whooping Cough	about 600

This should be borne in mind when considering the following table of cases of infectious diseases.

Disease.	The year 1914.	Year ending Nov. 30th, 1916, among civilians.
Chickenpox	....	175
Diphtheria	111	127
Measles	2	752
Mumps	....	199
Scarlet Fever	20	52
Smallpox	60	
Tuberculosis	18	152
Typhoid Fever	2	17
Whooping Cough	....	349
Poliomyelitis	6	4
Cerebro-spinal Meningitis	....	4
German Measles	....	31
Total	219	1,862

In considering the figures for 1914, it will be well to remember that according to Provincial Reports, London, in 1914, is credited with 64 deaths from tuberculosis while the Board of Health records show only 18 cases reported; with 5 deaths from typhoid fever, while only 2 cases were reported. Thus, with the exception of diphtheria, smallpox and perhaps scarlet fever, far more cases existed than were reported.

These preceding tables show conclusively that the apparent freedom of the city from certain infectious diseases, as compared with the present is entirely fallacious and due to the fact that the existence of infectious diseases in the past was not recognized or reported.

To illustrate:—Suppose the record of rainfall in Canada from the establishment of Government observatories to the present indicates so many inches per year. The absence of records previous to that date would induce no sane man to believe that there was no rain.

The Report.

The chief headway made by the Department in its work with infectious diseases in the city during the last year is that, through educating the public by distributing circulars, etc., it has obtained a great improvement in the reporting of cases of measles, whooping cough and the other so-called milder infectious diseases. Previous to this last year these diseases have received but little attention. In 1914, only two cases of measles were reported and not a single case of whooping cough. The records of previous years show no record of mumps being reported and chickenpox only when it was supposed to be smallpox. The result of this public health education carried on throughout the year has been very encouraging. Unreported cases of measles are rare. Whooping cough seems to be an exception to the complete reporting of cases and in this case our experience seems to indicate that parents fail to recognize the disease. An instance came to our attention where a mother sent her child back to school with a note to the effect that the child had not had an infectious disease, but had simply had a cough with spells of vomiting. When this case was investigated it was found that the history of the case left no doubt as to it being whooping cough that the child had had. Towards the end of the year indications pointed to a fairly complete reporting of whooping cough.

In obtaining more complete reporting of cases the Health Department has received much co-operation from the public school authorities via the nurses and teachers. Especially is this the case in whooping cough. For instance, in November fifty per cent. of the cases brought to our attention were reported from this source. As regards tuberculosis, the reporting of cases has improved somewhat over last year, but even last year was good in this respect. Of course, it cannot be said that all cases are reported. We feel that many of the early cases are still unreported, even where a physician has been called, but yet the situation is promising. The local health department owes much to the London Health Association under the supervision of Dr. D. A. Craig, Superintendent of the Alexandra Sanatorium, for its work in tuberculosis and also for its co-operation with the Health Department. Were it not for this association the work among the tuberculous of London would be badly neglected.

Another advance in the work with infectious diseases in the last year has been to use up-to-date knowledge of preventive medicine to make methods of isolation as lenient as possible, yet not too lenient and to make these methods systematic and not as a township M.O.H. once said at a Public Health Convention, " Handle each case as it arises and as you see fit," which means that in all probability every case was handled differently and some ignored entirely

Some of the changes made in the year are as follows:—

1. In measles, whooping cough, mumps and chickenpox and any milder infection, no immune contacts were quarantined.

2. In no case was the breadwinner quarantined except when he himself was the one infected.

3. In measles the isolation period was reduced from 21 days to 14 days from the date first sick or ten days from the appearance of the rash.

Our records show that these steps were quite justifiable.

For instance:—1. In measles, of 1,383 who were recorded as immune and, therefore, not quarantined; only 11 developed the disease (i.e., 0.8 per cent.). Such instances as the year went by, became rarer because it was learned through experience to judge as to whether or not the evidence of immunity given in each case should be accepted. In whooping cough not a single child who was allowed to attend school because of immunity, while his home was quarantined developed the disease. This is also true of mumps and chickenpox.

The chief benefit of these changes has been to save the immune children the loss of school as was the case under the old system of quarantine.

The infectious diseases (except tuberculosis) among the civilians of London and the soldiers stationed here during the year ending November 30th, 1916, were as follows:

TABLE No. 1

Disease.	Civilians.		Soldiers.	
	Cases	Deaths.	Cases.	Deaths.
Chickenpox	175	....	3	
Diphtheria	127	16 (a)		
*Measles	752	5 (b)	97	
*Mumps	199	1	66	
Scarlet Fever	52	2 (c)	10	
Smallpox	....	....	1	
Typhoid Fever	17 (d)	1	2	
Whooping Cough	349 (e)	6		
*German Measles	31	....	94	
Anterior Poliomyelitis	4	2		
Cerebro-spinal Meningitis	4	5 (f)	2 (g)	1
Total	1,710	38	275	1

(a), (b), (c), (d), (e), (f), (g). See notes on the following pages.

Table No. 2 which follows shows the cases and deaths among the civilians of London arranged according to the month of report of occurrence. In tabulating this table all errors in the records during the year have been eliminated as far as known. Only those cases are recorded as diphtheria, which had positive cultures, except in two or three instances where only one culture was obtained (which was negative) because of death on first or second day. Here, as the clinical diagnosis pointed strongly to diphtheria and on account of the death, the case was considered diphtheria. In considering the table it will be well to also consider the notes thereto as they may explain why the number of deaths, especially, may not agree with records elsewhere.

*The records here may be slightly in error as regards the cases of measles, mumps and german measles because the Health Department did not have direct control over these cases.

TABLE No 2.

Disease.	Dec.		Jan.		Feb.		Mar.		April.		May.		June.		July.		Aug.		Sept.		Oct.		Nov.		Total.	
	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
Chickenpox	9	....	30	....	30	....	39	....	10	....	10	....	9	....	24	....	1	....	1	....	5	....	7	....	175	......
Diphtheria	4	....	3	....	2	1	11	2	8	....	....	....	2	....	5	1	3	1	22	4	30	5	37	2	127	16 (a)
Measles..............	1	....	13	....	31	....	37	....	93	1	219	1	188	3	99	....	55	....	16	....	....	....	....	....	752	5 (b)
Mumps	7	....	52	....	75	....	42	1	14	....	6	....	3	....	....	....	....	....	....	....	....	....	....	....	199	1
Scarlet Fever........	2	....	6	....	2	1	5	....	7	....	6	1	8	....	3	....	6	....	1	....	3	....	3	....	52	2 (c)
Smallpox	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	......	......
Typhoid Fever	....	....	....	....	1	....	6	....	....	....	....	....	1	....	....	....	....	....	5	1	4	....	....	....	(d) 17	1
Whooping Cough......	....	....	1	....	7	....	7	....	13	1	14	....	9	....	54	....	47	2	52	1	75	2	70	....	349	6 (e)
German Measles	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	30	....	31	......
Anterior Poliomyelitis	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	3	1	....	1	....	....	(f) 4	2( )
Cerebro-spinal Menin.	2	3	....	....	2	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	(g) 4	5 (g)
Total........	25	3	105	....	150	3	147	3	145	2	255	2	220	3	186	1	113	3	100	7	117	9	147	2	1,710	38

See notes (a), (b), (c), (d), (e), (f), (g).

(*a*) *Diphtheria.*—Included in the number of deaths is a death registered as due to edema of glottis. Here a post mortem revealed the presence of diphtheria bacilli. This death is, therefore, included as due to diphtheria. It occurred in July.

Not included is a death registered by a local physician as due to diphtheria. This was not considered as diphtheria by the Health Department. Cultures from the nose and throat failed to reveal the diphtheria bacillus. Death likely due to a streptococcic infection. This death occurred in October.

(*b*) *Measles.*—Three of the five deaths (one in April and two in June) were registered as due to pneumonia, no mention as to measles preceding. As our records show that pneumonia complicated measles, these three deaths are included under measles.

(*c*) *Scarlet Fever.*—A case and death recorded in February was that of an Italian child taken off the train, sick, on its arrival from Italy. There was some doubt as to scarlet fever, but the death occurred before a reliable diagnosis was made. A post mortem failed to shed light as to the disease. The death certificate was filled in giving "scarlet fever (?)," as the cause of death.

(*d*) *Typhoid fever.*—Ten of the cases (no deaths) occurred in the Hospital for Insane, six in March, four in October.

(*e*) *Whooping Cough.*—The deaths among children having whooping cough were registered as follows:

Date of Death.	Cause of Death.	Immediate Cause.
April 9	Whooping Cough	Whooping Cough.
Aug. 29	Whooping Cough	Diarrhœa and vomiting.
Aug. 29	Whooping Cough	Diarrhœa, vomiting and burns.
Sept. 4	Cholera Infantum	Cholera Infantum.
Sept. 8	Gastro-enteritis	Gastro-enteritis.
Sept. 18	(No record of death could be found. Our information was obtained by the assistant M.O.H. when he released this family from quarantine.)	
Sept. 29	Whooping Cough	Convulsions.
Oct. 20	Whooping Cough	Debility.
Oct. 22	Whooping Cough (apparently)	Convulsions.

To decide which deaths to assign to whooping cough is rather a puzzle and will not be attempted. For instance, which of the four causes, whooping cough, diarrhœa, vomiting or burns given as the cause of one of the deaths occurring August 29th, was really the cause of death. From the above one might consider anywhere from three to nine deaths from whooping cough. The only solution (a very poor one) is to take only those deaths in which the cause of death was registered as whooping cough, (i.e., six deaths which is equally likely to be too high as too low).

(*f*) *Anterior Poliomyelitis.*—A death occurred in Victoria Hospital from anterior poliomyelitis. The patient was a child from the Muncey Reserve, brought here for treatment. This death is not included in the table, neither is the case.

A case of poliomyelitis came to our attention of a child who had recovered from the acute attack, which occurred in Ailsa Craig, but was not recognized. This child had moved to London with its parents a few days before the case was brought to our attention. This case is not included in the table, because the case (in the acute stage) did not occur in London, and also because at the time the child moved to London the six-weeks' quarantine period had expired.

(*g*) *Cerebro-Spinal Meningitis.*—One death occurring in December was of a case taken sick before December 1st, 1915. Another death that occurred in October was of a returned soldier (a resident of London) who had the acute attack 18 months previous in England. He had been in civilian clothes for some time and, therefore, was considered as such. Of the four cases that occurred in the year, three died and one completely recovered.

Tuberculosis.

Among the civilians and soldiers who were, previous to enlisting, residents of London, there were reported during the year ending November 30th, 1916, 152 cases of tuberculosis. According to the city death register there occurred 72 deaths in the same period. But included in these deaths are residents of outside places who died in London where they had come for treatment. Therefore, to be more exact and fair to London, we must exclude deaths of all non-residents (i.e., deaths in hospitals and other institutions of individuals who previous to entering these institutions were not residents of London). Besides this we must include deaths of residents which we are certain died of tuberculosis, but which were registered as due to other causes. This adds two deaths, one in March and one in April. Thus the revised statistics of tuberculosis in London for the year in question is as follows:

Table No. 3.

—	Dec.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Total.
Cases	11	7	20	23	18	12	6	13	12	9	9	12	152
Deaths ...	1	2	6	6	6	3	5	9	2	5	4	2	51

OTTAWA.

Dr. R. Law, Acting M.O.H.

In the absence of Dr. Lomer, Medical Officer of Health, on duty with Sanitary Division of the Army Medical Service at the front, it is my duty to present the Report of the Health Department for the year ending October 31st, 1916.

In doing so, I am glad to be able to report that all members of the staff have worked zealously to the end that we are able to show a decline in deaths from infectious illness and the closing of the year with a handsome surplus, as indicated by the report of Mr. McClymont, Secretary.

In view of this continuation of good work and good fortune, and the difficulty that those on small stationary salaries have to support themselves and dependents under the marked increase in the cost of living, it is regrettable that the small and wellearned increases recommended by your Board could not have been awarded to them. It is to be hoped that the civic finances next year can be so adjusted that we may be able to give them more than the well won praise of "Well done, good and faithful servant."

I have to report a further reduction in the staff, two of our sanitary inspectors, having been dispensed with during the year, Messrs. Proulx and Hudson. Both were efficient workers. Mr. Proulx, after nearly forty years arduous and faithful service, left us to enjoy a well-earned rest, with the best wishes of all members of the staff and the public generally. It is to be hoped that in future more generous arrangements can be made for retiring allowance to old employees—eight hundred dollars being all Inspector Proulx received after his long service.

I attach herewith various tables and the reports of sub-departments.

The tables of births and deaths for the past six years show that this has been a good average year. The total population shows a slight increase over last year.

A gratifying decline is noted in the deaths from pulmonary tuberculosis and diphtheria. The deaths from typhoid, excluding non-residents, are near the irreducible minimum. Scarlet fever, for the first time in many years, has not caused a single death.

We have been fortunately spared any visitation from the much dreaded infantile paralysis, so epidemic in New York this year with its dread wake of death and deformity.

Of smallpox, as in last year, we have also been entirely free.

The outstanding increases in deaths have been from the acute respiratory illnesses, notably pneumonia, which prevailed in a severe form last winter.

The estimated population is	100,561	
Total number of births for 1916	2,542	
Birth rate for 1916	24.20	per 1,000
Birth rate for 1915	26.83	per 1,000
Birth rate for 1914	24.92	per 1,000
Birth rate for 1913	26.38	per 1,000
Birth rate for 1912	23.98	per 1,000
Birth rate for 1911	22.83	per 1,000
Total deaths for 1916	1,926	
Still births	170	
Deaths of non-residents	213	
Corrected total deaths	1,543	
Death rate	19.15	
Corrected average death rate for 1916	15.34	per 1,000
Corrected average death rate for 1915	14.31	per 1,000
Corrected average death rate for 1914	15.26	per 1,000
Corrected average death rate for 1913	15.28	per 1,000
Corrected average death rate for 1912	14.14	per 1,000
Corrected average death rate for 1911	15.86	per 1,000

Tuberculosis.

Pulmonary tuberculosis still holds the premier place in the mortality list from communicable diseases, with 111 deaths. This, however, is 22 less than last year which is an encouraging sign.

In spite of the many years during which the value of fresh air and sunlight in the prevention and cure of tuberculosis has been urged, few seem to realize that the closed and sunless habitation, however elaborate its appointments, provides a passport to general impairment of health with its too frequent sequel, the consumptive's grave.

The great increase in diseases of the respiratory system during the winter months is due more to the debilitating effects of over-heated, unventilated habitations than to the cold air, the common term of cold being a most misleading one in this respect.

When little babies and delicate consumptives can, with great benefit, spend hours each day in the outer air there is no excuse for the stronger ones to weaken themselves by closed housing. If you want to be well this winter spend all the time you can outside in the fresh air and the rest of your time inside in the fresh air.

Diphtheria.

I am glad to be able to report a decided improvement in the diphtheria situation over last year, there being 21 deaths less from this cause.

The 32 deaths occurring this year figure out at four per cent. of all deaths under 15 years, which, according to elaborate statistics presented at the American Public Health Association by the Prudential Life Assurance Company is, the average toll from diphtheria.

When we possess a means so potent in the treatment of diphtheria as antitoxin, which is estimated to save over a quarter of a million lives each year in the civilized world, there is no reason why these deaths should have occurred; and they are more properly chargeable to delay in securing treatment than to diphtheria.—Delays are dangerous.

It is most unjustifiable for any one to undertake the treatment of sore throats or croupy conditions without advice of a physician. Lack of means is no excuse as the Department will see to any unable to pay.

Whooping Cough and Measles.

Much work is being done in looking to the development of a similar means to the treatment of whooping cough, so generally regarded by many as an inevitable ill of childhood, and, therefore, so difficult to control. Nineteen deaths were registered in Ottawa from this distressing disease during the past year.

Ottawa shared in the widespread epidemic of measles so prevalent this year. The general type was mild and the season favorable. There were eight deaths registered from it out of 869 cases reported.

The incidence of these diseases might be generally reduced if the general public would realize that coughs and colds in children are probably infectious and often the forerunner of whooping cough and measles; both of which diseases are more infectious before the development of definite symptons. The moral is to keep children with coughs and colds away from other children.

Typhoid Fever.

Our typhoid fever statistics show a further and pleasing decline. Deducting the cases from outside we find there have been but twelve cases reported with four deaths—a record which few places can equal.

Milk Station Work.

The report of Miss Davidson, Superintendent of the Modified Milk Stations, shows the increasing work being done by our nurses in this most important branch of our work. This work should be further aided through the interest aroused by the Better Babies Baby Week, inaugurated so successfully by the ladies of the Victorian Order this year. Most instructive lectures and demonstrations were given and much valuable literature distributed—insistence being placed upon the paramount duty of every mother who is physically able to nurse her child to do so. Failure to do this is robbing many little ones of their only chance of survival.

The total deaths of children under one year were 566, an increase of over 59 over last year. The greater incidence of respiratory diseases during the past winter and the long continued heat of the past summer have contributed to bring this about.

The presence of a large foundling institution in this city to which babies are admitted from the entire district surrounding, many of whom are in a most debilitated condition, contributes largely to this excessive mortality. One hundred and thirty-two deaths were registered here which should, in justice to the mothers of Ottawa, be deducted, leaving an infantile mortality of 434 among our general population, or at the rate of 171 per 1,000 births registered. Even this is yet too high, and is an indication of the great need of the educational work being carried on by the doctors and nurses in charge of the work at the Milk Stations.

The thanks of the Board are due to Drs. Tilley, Beroard, Brunet and Byrne for their services so generously given for the care of the children of the poor mothers coming to the clinics held at the stations.

In conclusion, I beg to thank you, gentlemen, for your hearty co-operation with the staff of the Department in our efforts to advance the interests of public health in our city.

COMMUNICABLE DISEASES REPORTED

Disease.	1915 November.	December.	1916 January.	February.	March.	April.	May.	June.	July	August.	September.	October.	Cases.	Deaths.	Remarks.
Typhoid Fever...	4	2	1	3	4	7	1	1	3	18	6	6	56	18	Re Typhoid, 14 were outside cases.
Pulmonary Tuberculosis....	10	6	7	7	14	15	15	5	15	7	9	12	122	111	
Other forms of Tuberculosis	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	23	
Diphtheria	70	50	32	32	26	17	30	22	7	24	20	51	381	32	
Whooping Cough	1	4	11	5	12	.....	10	12	4	8	2	.....	69	19	The total deaths from all these cases was 213, as compared with 249 last year
Chickenpox................	10	4	3	4	3	1	....	6	4	.....	1	17	53		
German Measles............	2	2	3	2	7	28	25	3	1	.....	.....	2	75		
Measles..................	.....	3	4	5	20	104	380	232	82	13	11	15	869	8	
Scarlet Fever	9	9	7	9	8	3	1	3	.....	4	7	15	68		
Mumps	.....	1	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	2		
Erysipelas	.....	.....	1	.....	.....	.....	3	1	.....	.....	.....	1	6	2	
Cerebro Spinal Meningitis..	.....	.....	.....	.....	3	1	.....	.....	.....	.....	.....	.....	4		
Total for the year....														213	

Superintendent of Isolation Hospital, Dr. R. P. Hardman.

I have the honor to submit to you a medical report of the Isolation Hospital for the year ending October 31st, 1916.

Number of admissions to hospital	453
Aggregate attendance	9,088
Average number of patients	24.9
Maximum number of patients, October 31st, 1916	40¾
Minimum number of patients, July 19th, 1916	6.
Percentage death rate of hospital	6.6

Contagious Diseases Admitted to Hospital.

Disease.	Admitted.	Discharged.	Deaths.	Death Per cent.
Diphtheria	368	344	24	6.5
Scarlet Fever	50	50		
Measles	25	25		
Erysipelas	2	2		
Other Diseases	25	25	4	

Other diseases consist of German measles, chickenpox, tonsilitis, quinsy, broncho-pneumonia, cerebro-spinal meningitis, epidemic, etc. The four deaths referred to were due to broncho-pneumonia.

Diphtheria.

There were twenty-four deaths from diphtheria. Of this number, six were moribund on admittance dying within eighteen hours of admission. Five died within forty-eight hours after admittance to hospital. The average dose of antitoxin given was twenty-two thousand units.

Death Incidence with the number of days case remained at home.

Days' Illness at home	1	2	3	4	5	6	7	8	9	10
Deaths	......	2%	4%	6%	8%					

Thus we find the death rate advancing as the number of days' stay at home increases, providing antitoxin is not given immediately. So— a word to the wise.

Laryngeal Diphtheria.

This year we had twenty-five cases requiring intubation and five of these died, giving us an enviable record of twenty per cent. This percentage has few equals, as the average per cent. rate for this class of disease is around thirty-six per cent.

Scarlet Fever..

We admitted twelve cases less this year than last year. No deaths.

No Mixed Infection.

From October 31st, 1914, to October 31st, 1916, we have been free from this trouble. But observation rooms to each ward would relieve all anxiety.

Bacteriology.

Swabs examined, negative, 1,640; positive, 969.

Swab Stations.

One more station should be added in Ottawa South.

NATIONALITY OF PATIENTS AS ADMITTED TO HOSPITAL.

Canadians	378	Scottish	10
English	22	American	13
Hebrews	13	Polish	5
Irish	2	Australian	2
Italian	3		

CHIEF FOOD INSPECTOR, J. B. HOLLINGSWORTH.

I herewith submit report of the work done by the Dairy and Food Inspection Branch of the Department, for the year ending October 31st, 1916.

RE MILK.

During the year, from 39 milk vendors, 2,605 samples were collected, an increase of 413 over last year. The inspector examines containers and temperature of milk, the sample is then sent to the laboratory for chemical and bacteriological test. Over 98½ per cent. were found up to our standard in butter fat and the bacteriological count runs most favorable. This shows an improvement over last year. One vendor was fined and two required to discontinue selling milk owing to unsatisfactory conditions.

Householders are warned of the need of keeping milk cold, clean and covered, after delivery to them, and also of the importance of prompt return of milk containers in a cleanly condition. It is against the law to retain and use these containers for other purposes as some do. The careless consumer in this way is doing his bit to increase the cost to every one else.

Several herds were tested this year for tuberculosis and only in one instance was a herd found badly affected. This should encourage the dairymen to have more tests made. In one of these herds the only re-acter found was a pure-bred animal bought by an enterprising dairyman at a large price, with the idea of further improving his stock. To protect dairymen against a repetition of such an experience something should be done, as has been done in other countries, to require test of all registered cattle previous to sale.

The dairyman should also be protected against an infection of his herd through the distribution of whey, etc., from cheese and butter factories to which milk from tuberculous herds have ready access. Measures requiring pasteurizing of these have been carried out in many progressive dairy countries with most marked benefit in lessening the spread of tuberculosis.

The milk By-law, proposed some time ago, requires that all milk should come from herds free from tuberculosis or be pasteurized. This, has not, as yet, received the necessary sanction. Efforts are being made to have the Dominion rules so amended as to make this more acceptable to the dairymen.

The experience in many places shows that the extent of tuberculosis is not so marked as many dairymen feel and its elimination not a matter of such difficulty.

With the increasing difficulty in getting needed milk and the more extensive districts inspected for it, Ottawa, like many larger places has arrived at the time where, in order to protect our citizens, the milk must be pasteurized, unless produced from tuberculin-tested herds. Under careful inspection, 70 per cent. is already pasteurized and other leading dairymen are considering installation of pasteurizers. Some tested herds are now successfully supplying milk so that a relatively small percentage would be affected. Of this number, many could readily obtain a free herd, when tested, with a very slight expense—an expense which in the end would really well recompense them as a tuberculous animal seldom gives a sufficient return to justify the trouble of keeping it.

SLAUGHTER HOUSES.

Our slaughter houses in, and on the immediate outskirts of the city, have been regularly inspected. Some improvements have been made, such as providing cooling rooms for meat, proper yards for cattle, some distance from the slaughter house, screens on doors and windows, sound floors, whitewashing the interior of building and the removal daily of all waste.

Five thousand seven hundred and fifty-three pounds of meat were confiscated as unfit for food. Three thousand one hundred and thirteen pounds of this was condemned for being tubercular.

Forty-one calves and fourteen sacks of frozen, boned veal were condemned and sent to burner.

Section 102 of the Public Health Act prohibits the sale of veal under four weeks of age. The Meat and Canned Food Act of the Federal Government sets the age at three

weeks. The legislature, at its last assembly legalized the sale of veal in Ontario at two weeks old, and under the present law the flesh of a two-week old calf can be sold in Ottawa as veal.

Re Bread, Etc.

Six hundred and seventy-five loaves of bread were confiscated and delivered to the City Charity Officer for distribution.

Two car loads of potatoes, partly decomposed, were sent to the dump last spring, and a quantity of canned goods.

A great deal of attention is being paid by the bakers, confectioners, shop and restaurant tradesmen generally to the elimination of flies, as the general public are well informed of the dangers from these pests around premises where food is prepared or sold.

The question of meat inspection at the time of slaughter is still before us. This cannot be properly dealt with until we have a public abattoir, properly controlled and sufficiently protected by law.

Eighteen ice permits were given last year for proper areas in the Ottawa, Rideau and Gatineau Rivers.

During the year we had sixteen prosecutions and fifteen convictions, with one hundred and forty dollars collected in fines.

In conclusion, I wish to state that the inspectors under my branch of the Department have performed their duties conscientiously and energetically.

City Bacteriologist, J. Race.

I have the honour to submit to you my report upon the work performed in the Civic Laboratories during the year ending October 31st, 1916.

During the year a total of 12,449 samples have been examined and reported upon as against 12,715 in 1915, and 10,805 in 1914. From the table on this page, showing the nature of the samples submitted, it will be seen that the slight decrease is due to the smaller number of diphtheria swabs received.

Month.	Water.		Milk.		Hypochlorite.	Foods and Drugs.	Diphtheria Swabs.	Sputum.	Widals.	Roadway material.	Miscellaneous.	Total.
	Chemical.	Bacteriological.	Chemical.	Bacteriological.								
1915												
November	9	243	227	216	130	5	792	14	8	8	12	1,664
December........	11	245	230	229	125	6	58	12	6	....	17	939
1916												
January	8	240	223	209	133	11	155	16	3	....	23	1,021
February	8	235	196	196	150	3	88	7	7	3	20	913
March...........	33	261	233	226	162	12	136	19	6	1	19	1,108
April............	29	236	181	181	132	9	33	15	10	....	20	846
May.............	26	276	233	239	104	4	40	14	11	53	19	1,019
June	25	282	176	176	100	1	39	16	3	29	20	867
July	25	245	244	256	100	14	7	14	3	132	27	1,067
August	26	262	228	248	54	16	19	23	7	26	25	934
September.......	25	265	209	211	90	20	15	13	5	21	31	905
October	25	268	222	251	100	16	142	38	9	18	77	1,166
Total for year....	250	3,058	2,602	2,638	1,380	117	1,524	201	78	291	310	12,449

Water.

The usual tables showing the chemical and bacteriological condition of the raw and treated water have been prepared on the standard forms adopted by the New England Waterworks Association, and may be obtained from me by those interested in this data.

The condition of the river water as regards turbidity and colour has again been favourable; no excessive turbidities occurred during the spring months and the colour

has remained comparatively low throughout the year. It is worthy of note that average colour of the water during the last three years is almost 50 per cent. less than in 1912-1913, the first year during which tests were made. An adequate explanation of this phenomenon cannot be put forward at present, but it is not improbable that it is connected with increased storage on the Upper Ottawa. Whatever the cause may be it has undoubtedly resulted in an improved physical appearance of the supply.

An ample margin of safety has been maintained in the city supply throughout the year, and this, in conjunction with the exercise of constant vigilance over other supplies, has cut the total number of typhoid cases in two. (111 cases, 1915; 55 cases, 1916). When the outside cases, over which the Department can exercise no supervision, are deducted, the reduction is even more remarkable. The cases and deaths which show no clear evidence of having contracted the disease outside the city are as follows:

—	Cases.	Deaths.	Loss of vital energy.
1911	1,160	76	$590,000
1912	1,300	84	660,000
1913	90	14	75,000
1914	86	9	56,000
1915	47	12	56,000
1916	12	4	18,000

Twelve cases and four deaths for a city of 100,000 people is a remarkable record that is almost without parallel on this continent, and one that compares favourably with the best European ones. Among the four deaths is one in which the patient, a foreigner, died before any information could be obtained as to where the disease was contracted.

I have calculated the saving to the city on a monetary basis that this reduction represents, and taking a very conservative estimate of the value of a life at $3,600, and the cost of a typhoid case at $275, this must be placed at upwards of $38,000, as compared with last year.

In addition, a great deal of suffering and misery has been eliminated; humanitarian considerations to which it is impossible to give numerical expression, but which are exceedingly real.

The above results show that the temporary measure of purification by means of hypochlorite under constant scientific control has been an excellent investment to the city, and instead of a fever spot to be avoided at any cost, as Ottawa was regarded at the time of my appointment, it is now absolutely above reproach in this respect.

The outside cases received in the city hospitals for treatment have originated from many sources, but this year has shown a remarkable decrease in the cases from Aylmer and Hull; not a single case has been traced to the latter source since the water treatment was commenced. Smith's Falls and Carleton Place have been the most prolific sources of outside cases, excepting one which will be referred to later, but it is satisfactory to note that Smith's Falls has also installed a chlorine plant and this will, no doubt, have a marked effect on the Ottawa statistics.

Wells.

Many of the wells in the city continue to be used despite repeated warnings that the water is polluted. Under the present by-law, these cases cannot be adequately dealt with, but amendments are under consideration and will shortly be placed before you for approval. Unless filled in, polluted wells will continue to be used so long as nothing untoward occurs, but these consumers should remember the fate of two families at Masham, P.Q., in 1916, who "went once too oft to the well," with the consequence that almost every member contracted typhoid and no less than eight died. If well users will not protect themselves it is the clear duty of the city to fearlessly exercise its authority. I cannot emphasize too strongly the warning given in my previous reports that the geological formation of Ottawa is exceedingly unfavourable for procuring water of satisfactory quality from wells and that wells should only be driven for industrial purposes.

Sputums and Widals.

The samples of blood received for the Widal typhoid test show a decrease and this can be attributed to the decreased incidence of this disease during the year. The majority of the specimens received were from outside cases in the hospitals.

The number of sputums received again shows an increase but the total is still absurdly small compared with the number of cases of tuberculosis in the city. Last

year I recommended that a blotter be prepared for distribution to the physicians with a short notice printed on it acquainting them with the laboratory facilities placed at their disposal. This, I would again urge upon you, as I am sure that the small outlay required would bring an adequate return. A public health laboratory needs advertising like every other business if the best results are to be secured. If the specimens will not seek the laboratory, the laboratory must seek the specimens.

Milk.

The bacteriological purity of the raw milk supply again shows a decided improvement, the average bacterial count being 181,000 per c.cm., as compared with 226,000 in 1915, and 284,000 in 1914.

The average chemical composition of the farmers' milks is about the same as last year, but 2.2 per cent. were deficient in fat and 10.8 per cent. deficient in total solids, as compared with 0.3 and 2.2 per cent. respectively for last year. These results do not necessarily point to increased sophistication; they are due, in my opinion, to lack of proper mixing in the cans before delivery. Samples have been received containing six per cent. and even as high as 7.8 per cent. of fat and if some customers are receiving milk of this quality, others must receive milk of correspondingly poor quality.

The average composition of the various classes of milk is as follows:

—	Fat	Total Solids.	Solids not Fat.	Bacteria per c.cm.
*Farmers' Milk	3.94	12.74	8.80	181,000
Pasteurized Milk	3.84	12.62	8.78	29,000
Nursery Milk	4.16	13.00	8.84	30,800
Certified Milk	3.96	12.67	8.71	8,200

*These figures represent the average of the genuine samples only.

Miscellaneous.

In addition to the bacteriological work for the Board of Health and Waterworks Departments, an increasing amount of chemical work is being undertaken for other branches and thus increasing the usefulness of the laboratories to the Corporation generally. The work received during the past year includes the following:

Board of Works.—Asphalt, sand, stone, and cement.

Board of Control.—Coal.

Police Department.—Beer, liquor, medicated wines, and miscellaneous samples for criminal cases.

Fire Department.—Oil, inflammatory materials, and investigations.

City Auditor.—Soap.

Charity Department.—Coal.

Food Inspector.—Foods for detection of adulteration.

In view of these facts, I think it is only equitable that the Board of Control should be requested to contribute towards the laboratory appropriation and that the proportions paid by the Health and Waterworks Departments should be reduced.

In conclusion, I wish to record my indebtedness to the laboratory staff whose cheerful co-operation and assistance have contributed so largely to the successful and economical administration of the Department.

Miss M. E. Davidson.

Supervisor of Modified Milk Depots.

I have the honour to submit the sixth Annual Report of the Infants' Milk Depots for the year ending October 31st, 1916. We find the work steadily increasing in each station. The Depots are, viz.:

No. 1, 249 Guigues (removed May 1st from 288 St. Patrick Street).

No. 2, 7 Irving Avenue.

No. 3, 298 Booth Street.

Owing to the coolness of the spring, we did not find it necessary to engage extra nurses until July 15th, when Miss Carpenter and Miss Leonard were taken on until October 1st. The continuous heat of July and August we found very hard on the babies, and it was necessary for the nurses to be on duty every Sunday during these

two months. The interest taken by the mothers is shown by the large attendance at each clinic, and desire on their part for the nurses' visits and advice. They are beginning to understand that sore eyes, ears, and other ailments are not a necessary accompaniment to the teething stage, but have been caused by lack of care and knowledge.

We still meet with the same trouble, delay on the part of the mother in reporting the child's illness.

If it were possible to do so, I would advise monthly talks to mothers given at the stations by the doctors, as I feel that the nurses have the mothers now so interested in child-welfare that they would attend in large numbers.

Owing to the advice and instruction of the nurses we find more mothers nursing their infants than formerly. This, with the fact that so many men have enlisted and are thereby able to buy milk for their babies, has lessened the number of milk-tickets given out each week.

During the summer of 1917, I would like to interest people who take ice for the season and ask them, when leaving the city for a vacation, to transfer the delivery of the ice to some poor person with young babies. It might be well to interest the daily papers in this project, as has been done in other cities.

The nurses wish to thank the Board for the car fare given each month.

On October 1st, Madame Desjardins resigned, and Miss Duhamel was appointed in her place.

We wish to thank the doctors for their hearty co-operation during the past year.

I submit the following statistical report for the year, which shows the great increase in the work:

Depot.	Babies treated at station.	Babies seen by Nurse at station.	Visits made by Nurses at homes.	Individual babies seen.	Milk tickets dispensed.		Deaths.
					qts.	pts.	
1.........	634	1,009	3,523	508	1,136	235	20
2.........	819	1,733	4,273	973	1,721	1,005	25
3.........	512	1,565	3,345	818	1,139	2,204	17
Total.	1,965	4,307	11,141	2,299	3,996	3,444	62

Cash to the City Hall, from Barley Flour $92 50

CITY OF PETERBOROUGH.

Dr. C. H. Amys, M.O.H.

I beg to present to you my report upon the sanitary condition of the Municipality.

During the ten and one-half months past we have been blessed with a freedom from any serious epidemic, as the reports on the following diseases will indicate:—

Measles.—We placarded 314 houses; this represented about 800 cases in all. Four deaths.

This epidemic commenced on November 27th, 1915, and, in spite of cases being promptly reported and isolation enforced, it spread all over the city in a few days.

The general opinion among medical men is that the quarantine for measles is too long; and I trust we will see a change in the near future.

Typhoid Fever.—Four cases; three deaths.

On September 1st was the last case.

Three or all of these cases came from out of town, or had been visiting out of town. It might be well for me to state that with two large hospitals and several public institutions in our midst, inhabited by what might be called a floating population, it is a marvel that we have been free, during the last year, of any serious epidemic.

Typhoid is a water-borne disease, and I would advise the Board to take immediate steps to better our domestic ice supply. If we continue to use, in the house and restaurant, ice cut from the Little Lake, we are certainly courting disaster.

Scarlet Fever.—Nine cases; no deaths.

April 19th gave birth to the last case. Several of these came from one institution where there was quite an outbreak towards the close of last year.

Diphtheria.—Forty-five cases; four deaths.

On October 11th was our last case.

The School Nurse's work, coupled with rigid isolation (Hospital treatment) was, I consider, the chief factor in eliminating this dread disease from our midst.

You will agree with me when I say that, as the School Nurse's work is chiefly, if not entirely, to do with public health, she should be employed by the Board of Health. We could then extend her work to the Separate Schools and Collegiate Institute and Normal School, and if necessary give her an assistant. I trust you will take this matter up with the School Board and Council before next year.

Tuberculosis.—No cases reported as required by law. Fifteen deaths recorded.

Smallpox.—No cases.

Chickenpox.—Three cases. This disease is not reported as required by law.

Erysipelas.—Two cases; no deaths.

Whooping Cough.—Three cases; one death.

Cerebro-Spinal Meningitis.—Three cases; two deaths. We had, I believe, only one case of the epidemic type during the year.

Infantile Paralysis.—No cases.

Before closing I wish to touch on the night soil problem, which is, I believe, causing our City Fathers a certain amount of thought and trouble. There is an axiom, "Tax anything and everything you want to get rid of." Tax, it, I say, and have no scruples about it, because almost every house in Peterborough has sewer and water at its door. These houses should be connected up, and every man, rich and poor, should know he is not taking the full advantage of this city's blessings if he fails to connect up. Sewer connection will make his property more valuable, give him more space, give him and his neighbours purer air, less flies, fewer doctors' bills, and a healthier and happier wife and family.

T. R. Cooper, Sanitary Inspector.

In submitting my first six months' report for your consideration it is somewhat difficult to give a complete statistical record of work performed during that time—from June 6th, 1916, to November, 1916.

Nine hundred and thirty-two calls and inspections of backyards and lanes answered and put right.

Six hundred and fifty-four scavengers' complaints.

Two hundred and ten garbage complaints, about half of which resulted from the employment of strange men; the other half, public fault.

Have made two visits to all slaughter-houses that supply meat to the city of Peterborough, and found them all O.K.

Have visited all milk vendors in the city and found everything in a very sanitary condition.

Have put up and taken down twenty-three diphtheria cards and six measles cards.

Inspected all butcher, fish and fruit shops at least once a week, and found them all willing to do what is right.

I have served ninety-eight Nuisance Notices, and in all cases they have been properly carried out.

Inspected all laundries and bakeries, and found them, all but one or two, in a sanitary condition.

I have caused to be removed and destroyed at the incinerator twenty-five dead animals of all kinds.

Have examined and inspected the banks of the River Otonabee above the Waterworks Dam, and also the river above the dam, twice, and found it in a sanitary condition.

The boarding-houses have been carefully inspected, and I have found very few causes for complaint. Of course, the Italian places are the worst.

I have inspected all eating houses and cafés, and have caused some of them to be put in better sanitary condition.

The foregoing report does not convey an adequate idea of all work done, as a great part of my time for three months was taken up with the scavenging difficulty—obtaining men to take licenses and placing them on routes; trouble with the incinerator man; getting incinerator in working order, and having to stay in my office at the first stage of my time trying to collect money for scavengers' work. Much work has been done in regard to night soil, but there is a great deal still to be done which I hope will be carried out in the coming year.

I must also say that Mr. Miller has given me much assistance which I have been very glad of.

CITY OF ST. CATHARINES.

DR. F. KING, M.O.H.

I beg to submit my Annual Report on the sanitary and other conditions relating to the public health of the city for the past year.

COMMUNICABLE DISEASES.

Of communicable diseases there were reported:

	Cases.	Deaths.
Measles	338	0
Scarlet fever	44	0
Diphtheria	21	4
Typhoid fever	27	2
Tuberculosis	16	21
Mumps	7	0
Chickenpox	5	0
Infantile paralysis	2	0
Infantile paralysis, suspected	1	0
Whooping cough	3	1
Spinal meningitis	2	2
Erysipelas	1	0
Anthrax	1	0
Total	468	30

The outstanding event of the year was the sudden and widely spread epidemic of measles. There were 338 cases recorded, but it is an undoubted fact that many cases were concealed, and others not reported. Little attention is given to this subject. The general public look upon the disease as an incident of childhood and one thankful to be over and done with.

I have observed that in every five to seven years this and other municipalities are visited by an epidemic of measles, more or less extensive, also that it is never satisfactorily controlled by the present or past quarantine regulations, for the probable reason that the quarantine period does not begin early enough. The time to control measles is a few days before the rash appears. The infection is spread through the child coughing and sneezing. The quarantine regulations, often onerous, might safely be modified and the period of exclusion cut short, especially in uncomplicated cases.

Another event of interest was the presence of infantile paralysis. Two undoubted cases were reported, also one suspected; and it appears on record, so I am informed, that one case contracted 20 years ago caused death.

It is worthy to note and creditable to be recorded that in the cases above cited the medical attendant supervised and carried out the most satisfactory precautions to prevent the spread of this dreaded disease, in striking contrast to the negligence brought to the notice of the Board early in the year.

TYPHOID FEVER.

There were 27 cases of typhoid fever recorded during the year. Of these, 25 were in the G. & M. Hospital, 13 were residents of the city, 10 were from the county, and one foreign to city or county; also one suspected case.

Recently it was discovered that seven cases had developed in one house. These had not been reported by the medical attendant until after the fact had become public. The origin of these cases was probably in Buffalo. All are included in the Hospital report.

TUBERCULOSIS.

There were reported 16 cases, with 21 deaths, to the Division Registrar; 25 cases were received into the Consumptive Sanitarium, 10 of which were from the city and 15 from outside places. Five deaths occurred in that institution during the year.

Vital Statistics.

Of the total mortality, 298 from all causes, pneumonia still keeps the first rank with 35 deaths; still and premature births numbered 30 as compared with 43 last year.

Children under one year of age	55
Children between one and five years	16
Children between five and ten years	10
Cancer accounted for	13
Heart disease	9
Old age, also	9

Sanitation.

The spirit of the Public Health Act is to prevent nuisances. Here we can only, as a rule, abate a nuisance after the fact. I again wish to point out that to prevent nuisances a more efficient system of sanitary inspection should be adopted, and I note that the official health records state that the city of Windsor has four (4) permanent sanitary inspectors employed. During the year 7,184 feet of new sewers, with 175 sewer connections, were completed or nearing completion. All houses where contagion had been present were fumigated as far as known.

The satisfactory disposal of garbage is still an unsettled question and should receive the earnest consideration of the Board and City Council in the near future.

Unsanitary, unsightly and offensive manure heaps still exist, even in congested parts of the city. In the absence of a more drastic handling of this question, we hope that the automobile may modify or lessen this form of nuisance. The standard of cleanliness of dairies, stables, cows, and for the handling of milk, has been raised. Clean milk is one of the most important articles of human food, but dirty milk containing manure and other foreign articles is one of the most dangerous. There is, however, a tendency on the part of producers to improve their surroundings, and in time, with advice and encouragement, the conditions will reach those demanded by the large cities.

The Isolation Hospital.

We are still without an up-to-date home for contagious diseases. The institution, however, is well managed and kept remarkably clean.

The conditions presented in the Facer Street district require consideration. Unfortunately the land is low and difficult to drain, but some system of drainage or sewerage is urgently needed and should receive prompt attention.

CITY OF WINDSOR.

Dr. G. R. Cruickshank, M.O.H.

I beg to submit my Annual Report for the year November 15th, 1915, to November 15th, 1916.

Perhaps the best measure of our success is the death rate, but this may be quite fallacious, for it may be great owing to the accidental presence of a virulent type of contagious disease or it may be small owing to many causes. For instance, since one-third of the deaths occur in infancy, in a community where there are few births one would expect a lower death rate. During the year ending December 31st, 1914, there were one hundred and twenty-two deaths occurring in infancy, and in the year 1915 there were one hundred and five deaths during this stage of life. But the death rate of 1916 may depend upon constitutions weakened by diseases of twenty years ago, so that the number of deaths is not the only measure of our success or failure, as is well illustrated by our outbreak of infantile paralysis, in which there were no deaths in our diagnosed cases, but fourteen children were crippled for life.

Infant Mortality.

Broadly speaking, one third of our deaths occurred in infancy, one-third from infancy to sixty years of age, and one-third over sixty years. This particularly directs our attention to the health of infants, for not only is the number of deaths appalling, but it is probable that many of the deaths up to sixty years of age are due to constitutions weakened in infancy. The number (twenty-five) of deaths before birth

or immediately after is surprisingly great, and no doubt many of the early deaths are not reported. The cause of this would make a good subject for discussion by the Essex County Medical Association.

In Detroit the Board of Health has a Maternity Clinic where prospective mothers are examined, advised and treated. This is giving good results, but there is at present no apparent prospect for us to secure physicians and nurses for this purpose. For infants who survive birth visiting nurses call at the homes and instruct mothers as to the proper care and feeding of young infants. This has, in Detroit, cut the death rate in half in their worst districts. In Windsor we had temporary nurses during the summer months searching for concealed cases of contagion, and incidentally giving advice to the mothers. This has had a very gratifying result. They found that milk probably good when delivered was so badly used in the homes that it became poisonous, and that infants were smothered with filthy clothing and covered with flies. It is surely possible for us to employ a few nurses to continue this good work.

Infantile Paralysis.

In Windsor this year we had fourteen cases positively diagnosed, and five suspected cases were quarantined. One of the suspects died. If we compare our population with that of New York it will be seen that our percentage would make three thousand in a city of four million. Although the physicians gave us every assistance, three of our cases were not discovered until after their recovery, and then only when the mothers consulted their family doctor about the persistence of a supposed sprain. The laboratory diagnosis of infantile paralysis is not yet practicable, and it is quite likely that many cases recovered completely and were never diagnosed.

We investigated thoroughly in every case all possibility of contact with dairies, milk dealers, grocers, water, ice cream, visitors, excursions, but were unable to establish in a single instance the source of contagion. Two cases followed a visit to Detroit's popular park, Belle Isle, but at that time there were no cases reported in Detroit. A number of cases in Windsor and bordering towns occurred in the families employed by a large motor factory. The factory was carefully inspected to see if the men were in contact or handled the same goods, or if any of the goods came from infected places, but without result. Moreover, we quarantined the entire families for six weeks.

The only possibilities of contact discovered were:

1. Most of the cases occurred in the families of Ford employees, but it must be remembered that there are three thousand men employed in this plant.

2. One child died after one day's illness of brain fever—cause not determined. We quarantined and disinfected. The father was a foreigner employed by a pavement contractor. The families of two other employees of the same company some ten days later showed infection.

It is remarkable that in no family more than one child was infected. Either many are not susceptible or many are infected mildly. We closed all schools, play-grounds, picnics and theatres to children under ten years of age, and maintained the strictest quarantine. The last quarantine was raised in the middle of September.

Scarlet Fever.

Twenty-nine cases were reported. No deaths.

Smallpox.

Five cases were reported. No deaths.

Measles.

Two hundred and sixty-seven cases were reported. One death.

Whooping Cough.

Three cases were reported. No deaths. Evidently very many cases were not reported.

Typhoid Fever.

Thirty-two cases were reported. Four deaths. Physicians are reporting their cases better than before, but our nurses discovered cases that were not reported, and only a small portion of the city was investigated then. That so much typhoid occurs in Windsor is surprising. Either chlorination of water is a failure or the chlorination

is not properly done. I inspected the plant on many occasions, and found, at one time, at 5 a.m., only one-half inch of solution in the tank, and on another date, at 2 a.m., I found the tanks full, the room dark, and not a drop escaping into the water. The caretaker should be arrested for manslaughter. Any method that depends on the watchfulness of man is sure to fail at times. Some mechanical non-failing device should be used, or a man of long-proven faithfulness employed. In the meantime I would urgently recommend that Thomas Hillier, the Sanitary Officer, be offered this post. I found, too, that the hypochloride used varies in strength, at least so far as smell can decide. I would recommend that a lot that seems weak be promptly returned.

Tuberculosis.

Five cases reported and twelve deaths. With a system of nurses this defective reporting would soon be remedied.

Windsor is rapidly filling with beautiful, well appointed homes without provisions for outdoor sleeping porches. Tuberculosis is almost universal; probably seventy-five per cent. of our adult population has been infected at times. The best known treatment for Tuberculosis is the Sanitarium. What is there that a Sanitarium can give that could not be provided by the same doctor at home? Diet, medicine, rest, sunlight, OUT OF DOORS. Not a single home is built for the wealthy without a sleeping porch. Can it be that this is too costly for a mechanic? Most homes have a porch. Would it add much to the expense to place a door over it instead of a window, so that at some time the completion of a sleeping room would be easy? Before long we will have outdoor school rooms for the subnormal children, and any new home will be out of date without a sleeping porch.

Diphtheria.

One hundred and fifty-three cases and fourteen deaths, with twenty-two carriers, were reported.

Diphtheria is spread chiefly by well children with the living germs in their throats and is a very rare disease during school holidays.

St. Alphonsus School had a very severe visitation, and Dr. Morand, the School Physician had swabs from seventy apparently healthy children sent to the government laboratory. Twenty-two of these were reported as carrying the active living germs in their throats. The school was promptly closed, and no child was allowed back until a swab was taken and the laboratory report pronouncing it free from diphtheria germs was received.

Disinfection.

It is now generally recognized that fumigation is insufficient. The patients and exposed should, after swabs have been taken and sent to the laboratory, be properly, bathed, especially their hair, and their clothing should be boiled where possible. The room should be scrubbed and the walls re-papered or whitewashed, rugs disinfected or aired. This can best be supervised by a trained nurse.

Nurses.

The work of the school nurse cannot be overestimated, but the work undertaken is too much for one. It has been found that about seventy-five per cent. of the children on coming to school have diseased teeth, tonsils, adenoids or glands. This should clearly show the wisdom of supervision before coming to school by a well trained nurse. I would earnestly press upon your honourable body the necessity for the appointment of four trained nurses as Sanitary Inspectors, one for each Ward. They could work in the schools as well as in the homes. These and one male inspector, with his motorcycle, would, I believe, save many lives and make the lives of all much more efficient and prolonged.

I would again urge upon you the necessity for an Isolation Hospital. In present conditions the task of maintaining a satisfactory quarantine is almost impossible, besides being very expensive to the city as well as to the unfortunate families who suffer.

Milk.

In spite of the increased cost, this is the best and cheapest food that can be bought to-day, yet if not properly handled it is a most dangerous poison. Milk from a tuber-

cular cow is usually free from tubercle, but the cow dung and stable swarm with them. The cow is covered with them, and the milkers' hands become loaded. From these same hands may come typhoid, diphtheria and all other contagious diseases.

Dr. Bowman has done much to improve the quality in every respect. Pasteurization properly done will destroy disease germs and should be insisted upon in all cases, except, perhaps, certified milk.

Our meat, fruit, vegetables are all carefully watched.

Plumbing.

The fyling of plans, specifications and inspections was continued. The Plumbing Inspector was dismissed by the Council and Inspector Wheeler asked to do the work. Unfortunately this left the Board of Health only one inspector, Hillier, to establish quarantine, see that it was observed, notify the schools and library, furnish necessaries, groceries, milk and fuel to the unfortunate as well as to disinfect.

Mr. Hillier is industrious and faithful, but he is about eighty years of age and has no means of transportation, so that during an outbreak of contagion he is overworked. It is to be hoped that the proposed Building Inspector will soon be appointed and Inspector Wheeler returned to his former work.

WOODSTOCK.

Dr. A. Mackay, M.O.H.

I hereby submit my annual report of the Health Department of the City of Woodstock, for the year ending 15th November, 1916.

Number of births during the year, 222.

Number of deaths registered during the year, 147, excluding 15 still and premature births; we have 132 deaths, giving 12 per thousand of the population, and excluding 18 deaths of non-residents who came to the city for treatment, we get a death rate of 10.5 per thousand of population.

Deaths were due to the following causes, viz.:

Still and premature births	15	Pneumonia	12
Bronchitis	2	Uremia	3
Accidents	4	Anemia	4
Heart Disease	19	Congestion of Lungs	3
Old Age	6	Influenza	3
Angina Pectoris	2	Tuberculosis	4
Arteriosclerosis	5	Obstruction of Bowels	13
Paralysis	7	Peritonitis	2
Heart Failure	7	Cancer	4
Cerebral Softening	3	Spinal Meningitis	3
Malnutrition	3	Cirrhosis of Liver	3
Whooping Cough	2	Apoplexy	2

and one each of the following: Diphtheria, pulmonary embolism, pulmonary hemorrhage, burn, cerebral tumor, scald, pleurisy, hydrocephalus, stenosis of pylorus, nephritis, hepatitis, cyanosis, albuminuria, infantile diarrhœa, typhoid fever, meningitis, cholera morbus, indigestion, spinal abscess, placental hemorrhage, tetanus, bright's disease, jaundice, concussion of brain, dropsy, cerebral abscess, compression of brain, hematomisis. The deaths occurring between the following ages:—

Still and Premature	15	From 40 years to 50 years	10
Under 2 years	14	" 50 " to 60 "	15
From 2 years to 5 years	6	" 60 " to 70 "	19
" 5 " to 10 "	1	" 70 " to 80 "	25
" 10 " to 20 "	4	" 80 " to 90 "	12
" 20 " to 30 "	10	" 90 " to 100 "	3
" 30 " to 40 "	12	Over 100 "	1

COMMUNICABLE DISEASES.

—	1915.		1916.											
	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	Total.
Scarlet Fever	2	....	3	....	....	....	....	1	....	....	....	2	....	8
Measles	....	2	14	15	62	56	44	8	1	....	....	....	1	203
Diphtheria	7	....	....	....	....	....	....	....	....	....	....	....	....	7
Chickenpox	....	....	2	2	....	....	....	....	....	2	1	....	2	9
Whooping Cough	....	....	....	6	12	....	15	17	1	39	6	4	....	100
Mumps	....	....	....	....	....	1	....	1	1	....	1	7	5	16
Tuberculosis	....	....	....	....	....	....	....	....	1	....	....	....	....	1
Typhoid Fever	....	....	....	....	....	....	....	....	2	1	2	3	....	8
Impetigo Contagiosa	....	....	....	....	....	....	....	....	1	....	....	....	....	1
Totals	9	2	19	23	74	57	59	27	7	42	10	16	8	353

MILK SUPPLY.

Monthly tests of the milk were made throughout the year. Butter fat was usually above the standard requirement. The sediment test during the early part of the year was not satisfactory, but has been good lately.

The Veterinary Surgeon reported that at his inspection the health of the dairy herds supplying the city milk was quite satisfactory.

The members of the Board visited the dairies supplying milk and found many of them badly kept, and the cooling and bottling rooms in a few cases were not satisfactory.

There are a number of wells still in use in the city, but the Board has stopped the using of a few of them, owing to the impure state of the water.

SANITATION.

There were many complaints by residents along Cedar Creek as to the pollution of the water during the summer. The City Engineer and the Board of Works have been at work removing the cause.

Many earth closets are still in use, although the Board succeeded in removing a number this year.

I would suggest that the City By-law be amended by extending the area in which outside closets shall be prohibited, said area to include all streets supplied with sanitary sewers.

I thank the chairman and members of the Board for their able and earnest co-operation in carrying on the work of the Health Department.

RENFREW.

DR. J. J. MCCANN, M.O.H.

I have the honour to submit to you the report of the sanitary condition of the town and the Health Department for the year ending November 30th, 1916, it being a review of the work done during the year and a few suggestions for the future.

There have been reported during the year 136 cases of measles with 3 deaths from resultant broncho-pneumonia, 2 cases chickenpox, 15 cases of mumps, 1 case scarlet

fever with one death, 9 cases of typhoid fever with one death, 4 cases of whooping cough, and 20 cases of diphtheria with 3 deaths. There was no smallpox during the year. Six of the typhoid cases were from out of town and were brought to the hospital for treatment. There were in all, 186 cases of communicable disease—a marked increase over recent years, thus necessitating increased work and expense.

Forty-one cases of communicable diseases were taken care of in the Isolation Hospital. During the measles epidemic the upstairs of the old town hall on Hall Street was equipped and put into service as an auxiliary Isolation Hospital. The Isolation Hospital Pest House and equipment are in good condition and the problem of supplying nursing and supervision, having been taken up by the Board and Council, is now nearing a solution.

Diagnostic outfits as supplied by the Provincial Board of Health have been distributed to the local physicians, and a supply of antitoxins, serums, etc., is kept on hand and supplied free of charge.

During the year there have been 136 births and 82 deaths.

The chemical treatment of the water supply is still carried on, and analysis at various intervals showed it to be satisfactory.

A number of complaints *re* nuisances have been investigated and remedied and on one occasion over 300 pounds of meat that was unfit for human consumption was ordered to be disposed of. A prosecution of the vendor in this instance followed, but a conviction was not registered.

There are altogether too many outdoor closets, the number increasing considerably this year. The scavenger system is entirely inadequate to the needs of the town, and I would urge again, as in my last report, that some means be taken to either urge or compel property owners to make sewer connection when such is easily accessible. A garbage collection is now under consideration.

Extension of water and sewer systems to the newer parts of the town should be made without delay. The District Officer of Health, Dr. Maloney, lately made an inspection of the town, and although his report is not yet to hand he intimated that the health and sanitary conditions in Renfrew were entirely satisfactory.

I wish to thank the members of the Board, Secretary and Sanitary Inspector for their assistance and co-operation during the year.